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# **BUSINESS LOGISTICS** in Modern Management

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## JOSIP JURAJ STROSSMAYER UNIVERSITY OF OSIJEK FACULTY OF ECONOMICS IN OSIJEK

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## BUSINESS LOGISTICS IN MODERN MANAGEMENT

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#### Foreword

Tradition continues - the Faculty of Economics in Osijek organizes for the 17<sup>th</sup> year in a row an international scientific conference on Business Logistics in Modern Management 2017. Certainly the reasons can be found in the outstanding importance of business logistics for the European and world economy. In the past year, logistics once again adopted and implemented large technological advances, increased multidisciplinary and growing importance within individual companies. At the same time economy figures point to even more logistics service delivered and further growth of demand for new logistics and interdisciplinary services in future. On the other hand, the interest of the scientific community for the Conference is increasing, which is evident in a large number of participants - 92 authors from Estonia, Poland, Germany, Slovakia, Montenegro, Serbia, Hungary and Croatia presented the results of their research through 39 papers.

Proceedings of international scientific conference Business Logistics in Modern Management, as a representative of scientific part of logistics and supply chain management, responds to all these challenges in the economy, and sets new scientific and professional standards for companies and countries in the region and across Europe. Proceedings publication is divided into 9 sections: transportation, production logistics, purchasing logistics, contemporary supply chain challenges, retail and distribution logistics, technology in logistics, maritime logistics, green logistics, and interdisciplinarity in logistics practice. Although section titles represent established logistics sectors, papers in them are contributing with new exciting unpublished research results from these areas. Actuality, significance and quality of issues raised and presented in scientific papers, and consistency and professional standards of the review process of earlier Proceedings of this Conference have also been recognized by relevant scientific databases like Thomson Reuters Web of Science Conference Proceedings Citation Index - Social Science and Humanities, EBSCO - Business Source Ultimate and Business Source Corporate Plus, Econlit Full Text, IDEAS, EconPapers, and Hrčak.

All the papers went through two double blind international reviews thanks to enviable group of international scientist gathered in Review Committee who have significantly contributed to the quality of the Proceedings and Conference as a whole. Our appreciation also goes to all participants of the Conference, to Ministry of Science, Education and Sports of Republic of Croatia, and to Faculty of Economics for its support.

This year's Conference was significantly enriched with plenary lecture from our keynote speaker, distinguished professor Stefan Seuring from Kassel University in Germany who talked about development and directions in sustainable supply chain management.

The success of the scientific conference is measured by the quality and quantity of papers that are being publicized through it, but perhaps even more by the people involved in it and the relationships they develop through it. Taking into account all of the above aspects of success, it is my pleasure to say that Business Logistics in Modern Management 2017 is a successful conference.

Davor Dujak, Editor

## I. TRANSPORTATION

October 12-13, 2017 - Osijek, Croatia

## TESTING GIBRAT'S LAW ON CROATIAN FREIGHT TRANSPORT AND LOGISTICS FIRMS

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#### Abstract

Gibrat's law states that growth rate of the firm is independent of firm's size. This paper tests Gibrat's law on the panel data of Croatian freight transport and logistics firms during the period from 2006 to 2015. The data from Bureau van Dijk's Amadeus database is used to test the Law. The sample includes 565 firms. The aim of the paper is to analyze whether the growth of the freight transport and logistics firms in Croatia depends of its size. The number of employees and sales of the firm are used as independent variables, while yearly sales growth is taken as the depended variable. In analysis is also included the age of the firm in order to control for variable other than the size that affect the growth rate of the firm. Using econometric model (fixed effects estimator) we find that there is statistically significant proportional connection between size of the firms and their respective growth rates, moreover the results shows the growth in number of employees has a positive impact on the growth rate. It means larger and older firms have slower growth rate. That is why the Gibrat's law is rejected in case of Croatian freight transport and logistics firms.

Key words: Gibrat's law, freight transport & logistics, panel data, fixed effects

#### 1. INTRODUCTION

Logistics is one of the tools that play a key role in the change and improvement of the economy. Logistics and transport industry provides significant macroeconomic contributions to national economy by creating employment, and creating national income and foreign investment inflow. On the microeconomic level, logistics industry is a key industry in increasing the competitive power of firms. Moreover, the logistics and transport industry has an important mission in revitalizing and improvement of the competitiveness of other industries. Today, all industries are dependent on logistics sector (Sezer & Abasis, 2017). Considering the significant role of the logistics and transportation firms in generating employment and innovations with which they contribute to their local economies, firm growth rates represent an important field of interest for researchers and growth support policy makers. One of the significant contribution to the firm growth theory was the one introduced by Robert Gibrat (1931) known as the Law of Proportionate Effects or commonly used Gibrat's law (hereinafter: the Law) where he states that the growth rate of a given firm is independent of its size at the beginning of the examined period.

Many authors who are introduced in the Section 2 have tested the Law on diverse industries, in different countries using different models and the results were similar when it comes to the industry. The focus was mostly dedicated to the manufacturing industry while later papers included service sector in their analysis. The differences between distribution of firms' sizes between manufacturing and service industry vary as well as the different structure of ownership relationship within firms in 1930s when compared to 21th century (Host & Zaninović, 2017).

There is evident a considerable number of studies showing the relationship between size and growth of firms in the developed nations i.e. Italy, UK., US, Spain etc. However, the researchers have come across only a few studies that had analysed the growth pattern of firms in developing countries (Aggarwal & Chander, 2008). The Law brings interesting connotations for determining the intensity of industry concentration and the significance attributed to testing its validity is quite understandable (Vuković et al, 2014).

The aim of this paper is to analyse whether the results of testing the Law on Croatian freight transport and logistics firms show the independents of the growth and firm size. The analysis was based on the panel data of 565 Croatian freight transport and logistics firms during the period from 2006 to 2015. It is important to emphasize that the time span of 10 years includes also the period before and after the EU accession which for sure had its impact on examined industry considering the dictated macroeconomic policies of the largest countries and integration by itself.

The paper is divided into the 6 sections. After the Introduction, section 2 gives the review of the relevant literature covering the Gibrat's law. The methodology of the research is explained in section 3. Section 4 presents the description of the data and descriptive statistics while the results and discussion are contained in section 5. Finally, section 6 concludes and gives suggestion for the potential further development of the analysis.

#### 2. LITERATURE REVIEW

A common interpretation of the Gibrat's law presented in numerous paper is that a firm's growth rate and its size are independent of each other. In other words, the Law states that small firms grow at the same rate as large firms. As mentioned above in the introduction, the considerable literature has rejected the Law, but various papers have found that the Law is valid for certain subsamples or time periods. Hence, the question is not whether Gibrat's law is valid, but rather when and in which industry it is valid. The main research question of this paper is whether the Law is valid for the Croatian freight transport and logistics firms. Robert Gibrat stated that "the distribution of firm's size which can be measured by sales and number of employees of firms, could be well approximated with a lognormal distribution, and the reason could be the nature of the firm's growth process, that is multiplicative and independent of the size" (Gonzalez-Val, Lanaspa & Sanz, 2010).

Earlier studies based on small subsamples of well-established and large firms tended to confirm the Law, because of the market structure which was mainly controlled by a smaller number of firms. This means that the earlier studies were showing faster growth of large firms than smaller ones (Teurel & Carrioza, 2008). The Law continued to receive more attention in the theoretical and empirical literature during 1960s and 1970s, but Sutton (1997) made a great contribution in understanding the Law clearer when stated that it is important to distinguish between absolute and relative growth of the firm and therefore the Law states only that the relative growth is independent of the firm's size. Furthermore, in his work Gibrat's Legacy he stated that the reason for incompatible results lies in the systematic differences in the sample selection, for example in the case of manufacturing sector, the findings mostly show that the Law in not valid whilst it is valid in the case of the service sector (Nassar, Almsafirb & Al-Mahrouqc, 2014). Another important fact is that the papers were mainly focused on testing the particular industry, while ignoring the attributes of a given country or region. What is specific for Croatia freight and logistics firms is that firms which are operating in Croatia mostly have their own logistic networks for their needs therefore integrated logistic service specialist suppliers are not numerous. It is still a young and growing field of business in Croatia.

After more than 70 years of Gibrat's seminal book, Bottazi et al. (2009) returned to the study of the French manufacturing sector. They examinated which properties of firm size distributions and growth dynamics characterize the aggregate dynamics and if they are, at the same time, robust under disaggregation, hence they analysed the size distribution, Gibrat's law, the growth rates distribution, and growth rate autocorrelation at both aggregate and disaggregate levels. The results rejected the Law, by showing that the growth process is independent of firm's size.

Audretch et al. (2004) examined whether Gibrat's law can be rejected for the services as it was for the manufacturing industry. His research was based on a large sample of Dutch firms from service industry. His findings showed that for the Dutch services industry, Gibrat's law was generally valid. Almus & Nerlinger (2000) tested the Law on the sample of West German manufacturing firms where they subdivided them into young firms which are technologically intensive and non-technologically intensive as well as in distinct size classes. The results showed the Law was rejected for both, technologically intensive and non-technologically intensive in all periods examined but there was no significant difference between both firm groups. This confirmed the thesis that smaller firms have larger growth potential than larger ones.

Goddard et al. (2002) and Oliveira & Fortunato (2003, 2006) used panel data analysis to test if Gibrat's law holds for Japanese and Portuguese manufacturing firms and the results were not supportive, hence the Law was rejected. In the case of Turkish companies, the results were two-fold, Gibrat's law did not hold in the case of cement, plastic and pipe, textile, medicine and chemical, steel iron, automobile and other industries because results showed that firm size and firm growth were not independent of each other. In the case of food, electrical machinery, electronics and transportation firms the Law was valid as the relationship between firm size and firm growth was independent. It important to emphasize that by using different approach, considering cross sectional correlation, the results were quite opposite because the Law was rejected in all industries except ceramics and electronics (Aslan, 2008). Calvo (2006) analysed whether small, young, and innovating firms have experienced a greater employment growth than other Spanish firms over the period from 1990 to 2000. The study was based on a sample of 1272 manufacturing firms in which only 967 of the firms survived for the entire ten-year period. In the case of Spanish young and innovative firms, the Law failed to hold since the results showed that old firms grow less than young ones, and innovating activity (both process and product) is a strong positive factor in the firm's survival and its employment growth. Moreover, it is possible that firm, as it grows, loses flexibility and organizational efficiency which can lead to the more difficult growth for large firms than to the small ones (Kwangmin & Jinhoo, 2010).

A significant number of empirical papers spanning an extensive range of countries, and including both small and as well large firms, resulted in a peculiar result; growth rates (of surviving firms) tend to systematically decrease with increasing firm size. The transport and logistics market in Croatia is quite young and in the process of growing. As far as we know, this is this first time that an analysis of the Law is tested on specifically freight transport and logistics firms. The conclusion of the analysis is that a considerable number of researches showed that small firms indeed grow faster than large firms. This is supported both by both theoretical and empirical evidence.

#### 3. DATA AND DESCRIPTIVE STATISTICS

In paper is used panel data available from Bureau van Dijk's Amadeus. The sample consists of 565 firms involved in the freight transport and logistics industry (Division 52 according to Nace Rev. 2) during 2006 to 2015 period. More specifically, division 52 consists of two groups and six classes and includes warehousing and support activities for transportation, such as operating of transport infrastructure, the activities of transport agencies and cargo handling. Group 52.1 includes operation of storage and warehouse facilities for all kind of goods while group 52.2 includes support activities for transportation (land, water and air transportation). Last class (52.29) of the group 52.2 is very broad and includes: forwarding of freight, arranging or organizing of transport operations by rail, road, sea or air, organization of group and individual consignments (including pickup and delivery of goods and grouping of consignments), issue and procurement of transport documents and waybills, activities of customs agents, activities of sea-freight forwarders and air-cargo agents, brokerage for ship and aircraft space, goods-handling operations, e.g. temporary crating for the sole purpose of protecting the goods during transit, uncarting, sampling, weighing of goods (NACE, 2008, p. 241).

In order to test the Law, three variables were used; sales, measured in thousands of euros, number of employees and age of the firm. Original sample consisted of 735 firms, but we eliminated all observations that had at least one missing value for any

of the three aforementioned variables during observed period (roughly 23% of the firms). As a robust check, it is tested the model that will be explained in the next section on the original sample and the results were not significantly different.

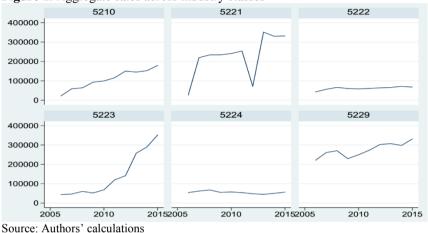


Figure 1. Aggregate sales across industry classes

Figure 1 presents aggregate sales across industry classes, where can be seen positive trend of sales in division 5210 and 5223 e.g. air transport, which is quite obvious considering the trend in the world where air transport mark positive trend. Moreover, according to the International Air Transport Association (IATA, 2017) the global air freight markets are showing that the demand, measured in freight ton kilometers (FTKs) grew by 3.8% in 2016 compared to 2015. Furthermore, the industry's average growth rate was 2.0% over the last five years. The trend regarding other two variables, 5222 and 5224 is relatively stagnant throughout the period, while the trend in 5221 shows significant decrease in the period after 2010, when the economic crises in Croatia was at its peak.

Unlike the trend in aggregate sales, Figure 2, number of employees shows the stagnant trend in 4 out of 6 observed industries. The only industry where is evident oscillating trend is land transport, where, as in the previous figure can be seen significant drop in the period during 2011 and 2012.

Figure 1 presents aggregate sal

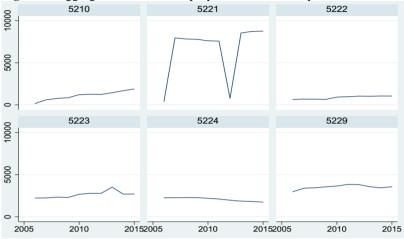


Figure 2. Aggregate number of employees across industry classes

Source: Authors' calculations

Table 1 contains descriptive statistics for division 52 in general, as well as for each of the particular classes within division. It can be noted that group 5229, other supporting industries makes the most important share in the division 52 while air transport makes the smallest share in division. The most employed persons are in air transport industry while other supporting industries have the smallest number of employees. When considering the average amount of sales, air transport with more than 12 million euros on average has the dominant position, while the land transport with 500 000 euros on average, the last position in observed sample. The highest standard deviation can be noted in land transport sales, as well as the coefficient of variation, while the lowest standard deviation is present in water transport sales, but coefficient of variation shows that standard deviation is 3 times higher than average.

Division /Class	No. of	Variables	Obs.	Mean	Std.	Min	Max
	firms				Dev.		
		employment	3,447	48.75	335.5	1	7455
52	565	sales	3,447	2530	11593	0.0185	201598
		age	3,447	13.65	10.73	0	70
5210 -		employment	231	48.24	149.0	1	919
warehousing &	48	sales	231	4689	12936	0.980	100887
storage		age	231	13.32	8.414	0	32
5221 – land transport	86	employment	459	143.7	871.2	1	7455
		sales	459	500	25177	0.0185	201598
		age	459	14.31	10.07	0	69
5222 weter		employment	352	24.87	49.72	1	278
5222 – water transport	57	sales	352	1748	4413	0.226	28397
		age	352	16.21	13.44	0	70
5223 – air		employment		220.3	276.5	1	878

Table 1. Descriptive statistics of the three main variables across industry classes

transport	19	sales	119	12040	24528	6.409	147344
		age	119	15.94	12.14	0	53
5224		employment	121	171.4	258.1	1	983
5224 – cargo handling	19	sales	121	4556	6779	2.927	26689
nanuning		age	121	27.92	24.41	0	70
		employment	2,165	16.27	49.42	1	609
5229 - other	336	sales	2,165	1267	3854	0.136	47060
supporting		age	2,165	12.20	8.309	0	69
industries							

Source: Authors' calculations

#### 4. METODOLOGHY

The most simplest way to test the Law is the one that includes regression with two variables, dependent  $(y_{it})$ , that is the growth of the firm, usually proxied by the change in sales between years, in time period *t* and independent variable  $(x_{i,t-1})$ , that is, the size of the firm in time period *t*-1 (proxied by the level of sales). Practically, this means estimating the following equation:

$$lny_{it} = \beta_0 + \beta_1 \ln x_{i,t-1} + \varepsilon_{it}$$
[1]

We emphasize that we did logarithmic transformation of the variables in order to be able to interpret the  $\beta_1$  as the elasticity, although this is not technically required. If  $\beta_1$  is around 0, then the Law holds, while if  $\beta_1$  is significantly different than 0, the Law doesn't hold. We used [1] as the backbone of our econometric model, although we expanded it with two variables that affect the growth of the firm, namely number of employees (other proxy for the size of the firm) and the age of the firm, that can be proxy for competitiveness of the firm.

If we were to use approach model in aforementioned process of econometric modelling, the basic econometric model could be the following:

$$growth_{it} = \beta_0 + \beta_1 sales_{it} + \beta_2 empl_{it} + \beta_3 age_{it} + a_i + \lambda_t + u_{it}$$
[2]

Equation 2 presents our econometric model. Growth of the firm is calculated as the difference in the log of sales between *t* and *t-1* period. Sales and employment are log-transformed while the age is in absolute terms. Individual effect is denoted with  $a_i$ , aggregate time (yearly) effects are denoted with  $\lambda_t$ , while  $u_{it}$  is a stochastic error term.

In order to estimate it, we first employed both fixed effects (FE) estimator and random effects (RE) estimator, although even before using them, we suspected that FE will be more suited to our data, since it is plausible to assume that idiosyncratic component  $(a_i)$  will be correlated with the regressors. Hausman test (results of the test are contained in Table 2) confirmed that RE is not consistent and that we should stick with the FE.

Testing Gibrat's law on Croatian freight transport and logistics firms Helga Pavlić Skender, Petra Adelajda Mirković, Vinko Zaninović

	(b)	(B)	(b-B)
	FE	RE	Difference
L1. Insales	-0.552	-0.317	-0.235
L1. lnempl	0.0416	0.243	-0.201
L1.age	-0.0201	0.00335	-0.0235
year			
2008	-0.0298	-0.0509	0.0211
2009	-0.116	-0.174	0.0580
2010	-0.108	-0.154	0.0454
2011	-0.0424	-0.0916	0.0492
2012	-0.0711	-0.182	0.111
2013	-0.0720	-0.200	0.128
2014	-0.0515	-0.212	0.161
chi2(10)	474.2		
Prob>chi2	0		

Table 2. Results of the Hausman test

Source: Authors' calculations

#### 5. RESULTS AND DISCUSSION

Results of the estimation of Equation 2, shown in Table 3, clearly indicate that the Law doesn't hold for the division 52 as well as for each of the particular classes within division. Moreover, results indicate that smaller firms grow faster (this is noticeable from the sign of the coefficient lagged log of sales, which is negative). If the size of the firm grows by 1%, the growth of the firm will be lower by 0.5% on average. Regarding the variable number of employees, the coefficient is only significant for the support activities in the air transportation, higher the number of employees (by 1%), higher the growth of the firm (by 0.2%). Coefficient for the age of the firm is mildly negative and significant for the division 52. This indicates that performance gets worse with age due to organizational rigidities that are possibly developed throughout the years etc.

Generally, we can see that the explicative power of the model (R-squared) is quite high, given the sample limitations and relatively low number of variables that are included in the model, it varies from 30 to 46%.

-								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	52	5210	5221	5222	5223	5224	5229	
VARIAB LES	growth	growth	growth	growth	growth	growth	growth	
L.Insales	-0.552***	-0.671***	-0.462***	-0.563***	-0.543***	-0.505**	-0.574***	
	(0.0462)	(0.185)	(0.0555)	(0.130)	(0.106)	(0.203)	(0.0637)	
L.lnempl	0.0416	0.0323	0.0557	0.228*	0.00437	0.124	0.0441	
	(0.0340)	(0.0736)	(0.156)	(0.115)	(0.0305)	(0.149)	(0.0421)	
L.age	-0.0201***	0.000480	-0.0385	-0.0442**	0.0296	-0.0128	-0.0169*	

**Table 3.** Results of the estimation of Equation 2

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	(0.00754)	(0.0153)	(0.0239)	(0.0183)	(0.0215)	(0.0217)	(0.00987)
2008.year	-0.0298	-0.0166	-0.121	0.0800	0.176	-0.0665	-0.0411
	(0.0473)	(0.156)	(0.187)	(0.0715)	(0.140)	(0.0729)	(0.0602)
2009.year	-0.116***	0.00942	0.162	-0.162	0.0823	-0.247*	-0.156***
	(0.0432)	(0.117)	(0.195)	(0.0973)	(0.148)	(0.118)	(0.0556)
2010.year	-0.108***	0.0555	-0.0393	-0.0802	-0.152	-0.246	-0.127**
	(0.0400)	(0.120)	(0.101)	(0.123)	(0.154)	(0.145)	(0.0558)
2011.year	-0.0424	-0.0236	0.176	-0.0380	0.187	-0.224*	-0.0849
	(0.0415)	(0.127)	(0.115)	(0.0965)	(0.140)	(0.126)	(0.0575)
2012.year	-0.0711**	-0.0946	0.0654	-0.134	-0.0387	-0.301**	-0.0753*
	(0.0330)	(0.149)	(0.0904)	(0.108)	(0.144)	(0.136)	(0.0442)
2013.year	-0.0720**	0.0666	-0.0689	-0.0822	-0.00135	-0.233*	-0.0822
	(0.0363)	(0.105)	(0.0975)	(0.0695)	(0.107)	(0.129)	(0.0512)
2014.year	-0.0515	0.0636	-0.138	-0.00692	-0.0935	-0.178	-0.0433
	(0.0403)	(0.110)	(0.124)	(0.0769)	(0.176)	(0.232)	(0.0553)
2015.year	-	-	-	-	-	-	-
Constant	3.405***	4.122***	3.135***	3.591***	3.757***	3.777**	3.308***
	(0.275)	(1.248)	(0.439)	(0.674)	(1.035)	(1.714)	(0.360)
Observati	2,830	178	365	288	99	102	1,798
ons							
R-squared	0.330	0.383	0.306	0.466	0.441	0.342	0.335
Number	513	43	74	54	19	16	307
of id							

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Authors' calculations

#### 6. CONCLUSION

Since Gibrats's original formulation, the Law has been intensively tested. In the earlier researches, it was mainly focused on manufacturing industry and later on, on service industry. The results of testing vary across different countries, subsamples and market structures. In this paper is used panel data analysis to test the validity of the Law focused specifically on the Croatian freight transport and logistics firms. The aim was to analyse whether the holds in case of Croatian freight transport and logistics firms, namely if the growth is independent of the firm's size. The analysis was based on the panel data of 565 Croatian freight transport and logistics firms (division 52, Nace Rev. 2) during the period from 2006 to 2015. To test the Law, three variables were used; sales, measured in thousands of euros, number of employees and age of the firm. The results of the estimation showed that the Law doesn't hold in the case of Croatian freight transport and logistics firms, namely for division 52 as well as for each of the particular classes within division. Furthermore, results indicate that in our case smaller firms grow faster than larger ones. The analysis showed the same results in most of the empirical works dedicated to service sector. Hence Gibrat's law was rejected for Croatian freight transport and logistics industry as the growth rates have been found to be associated with firm size. As for the future research, there should contain more variables that best describe the structural relations between classes within the group.

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## SYNERGY IN LOGISTICS PROCESSES FOR RAILWAY TRANSPORT

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#### Abstract

Monitoring synergies of logistics processes in railway transport is currently considered a novelty and it is very actual. The main reason of solutions synergies are their growing importance in the case of necessary operational responses. Synergy is the creation of a whole that is greater than the simple sum of its parts. It is an innovative resolution because synergies in logistics processes related to the railway transport have not been addressed in research and scientific projects in the greater extent thus far. The integral part of the synergies is the quality in railway transport which includes the never-ending logistics processes. Railway undertakings in cooperation with other participants of the transport market and suppliers are constantly working on the quality of logistics processes and their improvement. Methods to improve logistics processes in railway transport are technical standards (ISO) or different methods: Total Quality Management, Deming cycle - PDCA cycle, Six Sigma, DMAIC Improvement Cycle and EFQM Excellence Model. Qualities of services in railway transport significantly affect all stakeholders in international transport chain. This paper is focused also on monitoring the costs of quality, which is done monthly and yearly with the exact division of the costs of this kind. The internal and external quality cost, prevention and evaluation costs are added to the total cost of quality. The result of the research should create a report about costs of quality logistics processes in railway transport.

Key words: synergy, synergies, logistic process, costs of quality, railway transport

#### **1. INTRODUCTION**

Choice, watching and efforts to manage parameters of logistics processes in railway undertakings depend on the conditions of internal and external business environment. These are processes that take place in space and time, at which increasing their dynamics and grows chaotic their course. It raises the quantity and quality of the interaction of these processes, which, if not controlled or regulated, can be deepened (Nedeliakova et al., 2015). These mentioned interactions are as one of conditions formation of synergies.

The main reason for synergies in railway transport is their growing importance, and if required - operative interventions to railway operations that affect the quality of services. In these cases, there are a lot of dynamic factors that affect the quality negatively, which evolve constantly over time (Kampf et al., 2016). In most cases, it goes about unsatisfactory communication between managers infrastructure and carriers which significantly affects quality of services provided. This situation then ultimately affects satisfaction and the needs of existing customers of railway undertakings as decisions of potential customers about the use of railway transport for the future.

It is about an innovative view on the issue of synergies because until now the synergy related to railway transport has not been researched to a greater extent in research and scientific projects.

#### 2. SYNERGY AND SYNERGIES

Due to the very wide range of tasks and cooperative collaboration of two or more subsystems (external business partners, internal organizational units and teams and etc.), synergy in their management applications is very widespread with diverse content. Therefore, it is necessary to establish appropriate classification effects arising from their acts (Vodáček & Vodáčková, 2009, p. 170).

#### 2.1. Research synergies of logistics processes in railway transport

For the classification of the type of synergy that can be a source of inspiration for modern management, synergies are defined as a cooperation between manager infrastructure and carriers according to these prominent authors:

A) Peter A. Corning (Corning, 2003, p. 468)

 $\rightarrow$  Synergy of functional complementarities - are the cases synergy that accrues from accouplement accessories. Nowadays, the emphasis is placed on the effective cooperation within the meaning of the communication between manager of the railway infrastructure and the carriers whose services for customers each represent complements, i.e. they are linked, unable to exist without each other.

 $\rightarrow$  Synergy of emergent phenomena - present in the cases of qualitative changes that occur due to mutual internal interaction of partial subsystems. In the implementation of the quality management system of railway undertakings, it is about an effort to improve services. Qualitative changes are necessary for the effective functioning of

railway undertakings on the transport market. Their implementation is difficult in terms of time and people factor but they bring significant effects in logistics processes. Moreover, it is usually difficult to convince managers railway undertakings and employees that change is necessary.

 $\rightarrow$  Synergy of augmentation or facilitation - in this category synergy are expectations about synergies that alter the character of existing logistics processes, as they activate their change respectively. When crossing railway undertakings on the process control has been a significant change their character compared with previous processes.

 $\rightarrow$  Synergy of joint environmental conditioning - can go about cooperative effects that arise from joint efforts by groups of people to influence both the internal and external environment in which they operate. An example is the cooperation between manager infrastructure and carriers in favour of railway transport in order to increase competitiveness.

 $\rightarrow$  Synergy of risk and cost sharing - it goes about the joint reinsurance against adverse effects respectively about the reduction of their occurrence and drop. On the railway network it gives rise to various risk situations that affect traffic flow, services of manager infrastructure, carriers and ultimately customer satisfaction. In this case, it is necessary to share the risk between individual participants of respective service providers so that customers do not perceive it in these situations.

 $\rightarrow$  Synergy of a combination of labour - the case of this synergy refers to the creation of conditions for the collection of the same or similar activities, so that individual activities is not conducted twice and so that the division of labour would stay fair.

 $\rightarrow$  Synergy of convergent effects - these are the cases that warn of the permanent effect of random phenomena and processes. This type of synergy can have large effects, and in railway operation stochastic effects (for example: failure of the drive railway vehicle, failure of wagon, failure of safety device, a suicide attempt an unnatural death, unplanned closures, adverse weather, natural disasters and etc.) can act on the necessity of demanding operative interventions.

B) Igor H. Ansoff (Ansoff, 1990, p. 499)

 $\rightarrow$  Sales synergy - it arises when different services use shared distribution channels or selling points. In the case of railway passenger transport it is the sale of different types of travel documents on the whole railway network and transport alone.

 $\rightarrow$  Operating synergy - it results from the economical use of facilities and personnel of railway undertakings.

 $\rightarrow$  Investment synergy - this synergy category is the result of improved recovery of resources. In railway undertakings it refers to a more effective management of logistics processes (management of wagons, management of drive railway vehicles, management of invest resources to maintenance and repairs of railway infrastructure, and etc.).

 $\rightarrow$  Managerial synergy - it occurs when the new railway undertakings recover existing well-established management knowledge.

C) Robert S. Kaplan and David P. Norton (Kaplan & Norton, 2008, p. 336)  $\rightarrow$  Financial synergy - it is the integrated management of logistics processes in the value chain of business activities of the railway undertakings.

 $\rightarrow$  Customer synergy - creation and implementation of joint offers to customers. In relation with transport services it comes to getting and keeping satisfied customers.

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 $\rightarrow$  Synergy of internal processes - in this type of synergy goes about practical and effective changes in logistics processes railway undertakings for providing better quality services.

 $\rightarrow$  Learning and growth synergy - association of innovative technologies in the field of logistics processes and customer services.

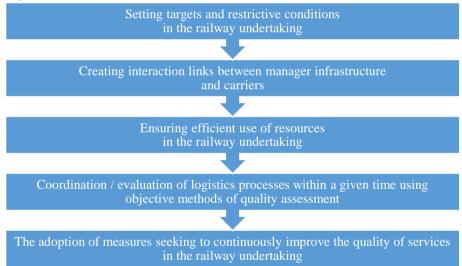
D) Michael Goold and Andrew Campbell (Goold & Campbell, 1998, p. 221)

 $\rightarrow$  Integration type synergies

 $\rightarrow$  Emergence type synergies

Integration type synergies belong to the synergy whose effects can be quantitatively evaluated. They arise by the cooperation between minimally two partial processes of different levels of management railway undertakings. They are processes that can be objectively monitored using, for example, statistical methods of quality management. Projecting and using the integration type synergies and their effects are expected in the needed time period as it is characterized in the following figure.

Figure 1. Projection and use of integration type synergies and their effects in a time sequence



Source: authors

The basic idea for the formation of models synergies of integration type is suitable distribution (allocation) or redistribution (reallocation) activities and considered resources subsystems and their use in favour of functioning of systems that create these subsystems. Contrario sensu emergence type synergies are synergies in which arising effects are completely or largely qualitatively different from resources subsystems. In one of their publications Goold and Campbell reported that "the results of emergence effects are manifested in the features, in the abilities to behave and in the results system of managerial work as a whole". There are various types of models closely related to this synergy. One of them is Model of Critical Success Factors (Zefreh et al., 2017). For modification logistics processes with focus on the railway transport see the following figure.

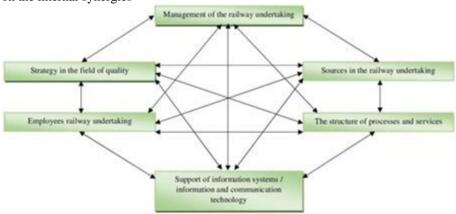


Figure 2. Model Critical Success Factors railway undertaking and their book bands on the internal synergies

Source: authors

The purpose of the Model of Critical Success Factors is to focus attention of managers railway undertaking on those aspects of their work that are essential for a more efficient provision of services. As far as the outputs are concerned, there are suitable selected arrangements of indicators activities for this undertaking. These indicators are characterized by prosperity, stability, competitive position and others. The functioning of individual sub processes is modified depending on their interactions with each other. This interaction can vary in time, and emerging synergies may change over time, such as changing the quality of services.

Synergies are closely linked to quality, which has origin in Latin and generally describes the "value" of something or some object (Nedeliakova et al., 2016).

#### 2.2. Quality and costs of quality

Quality is a matter of judgement made by customers or users of a product or service. It is the extent to which customers or users believe a product or service surpasses their needs and expectations. Howard Gitlow et al. inform that quality also encompasses the never-ending improvement of a firm's extended process. This term refers to the expansion of the organization to include suppliers, customers, investors, employees, and the community. These are all integral parts of the firm's extended process (Gitlow et al., 1989, p. 603).

The extended process brings together all stakeholders in logistics processes and is of great importance for the monitoring of synergies that arise from the provision of services in railway transport. The following figure defines the view on the extended process of service provision.

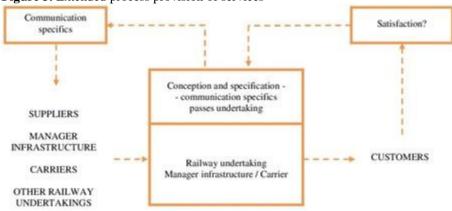


Figure 3. Extended process provision of services

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Source: Gitlow et al. (1989), edited by authors

Based on Figure 3, it is to be noted that the extended process begins communicating about the needs of the customer and it is important to realize the ultimate goal. Railway undertaking in cooperation with other participants of the transport market and suppliers work together on the quality of logistics processes and services, and on the improvement of the extended process.

Qualities of services in railway transport significantly affect all stakeholders in international transport chain. Indispensable parts of the quality are its costs, whose monitoring is very important. Quality costs represent a sum of costs incurred in maintaining acceptable quality levels plus the cost of failure to maintain that level (cost of poor quality).

#### 2.3. Impact of international organizations on the quality in railway transport

Quality of service and logistics processes in railway transport significantly affect international organizations whose members include railway undertakings in whole Europe.

#### 2.3.1. International Union of Railways (UIC)

UIC is the largest worldwide railway organization with members from all five continents. It maintains and develops connection of the railway system and allows for interoperability. Its basic objective in the field of service quality in railway transport is the development of specific-railway methods for optimizing logistics processes - improving efficiency and economy.

#### 2.3.2. Organisation for Cooperation between Railways (OSJD)

OSJD was established as the equivalent to the International Union of Railways, in order to create and improve the coordination of international railway transport. Concerning especially the transports between Europe and Asia, it has helped to develop cooperation between railway companies and other international organisations. The members of this organisation issued an international transport law. OSJD is presently working in the following areas:

 $\rightarrow$  Specification of technical parameters for high-quality freight lines

 $\rightarrow$  Confirmation and simplification of legal regulations on procedures at frontiers related to transportation across the Eurasian continent, delivery terms, financial responsibility, and etc.

 $\rightarrow$  Creation of competitive conditions for acceptance and carriage of large freight volumes to improve OSJD members' financial conditions

 $\rightarrow$  Development of new forms of freight carriage by block freight trains from large-scale senders to large-scale receivers in shortest possible time at competitive prices (OSJD, 2017).

# 2.3.3. The Voice of European Railways (CER)

The role of CER is to represent the interests of its members on the European Union policy-making scene, in particular to support an improved business and regulatory environment for European railway carriers and railway infrastructure undertaking. Its members and partners come from all states of the European Union, Norway, Switzerland, Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia including Kosovo, Turkey, Japan, Georgia, Moldova and Ukraine (CER, 2017). CER's vision for the European railway sector:

 $\rightarrow$  A competitive and viable first-choice transport mode in terms of price and service quality for both passengers and freight customers

 $\rightarrow$  The backbone of a seamless and integrated transport system – in close cooperation with the other transport modes

 $\rightarrow$  An enabling factor for the competitiveness of the European economy, supporting economic growth and job creation, and contributing to an inclusive society

 $\rightarrow$  Central to the delivery of Europe's goals of cutting greenhouse gas emissions, achieving energy security and relieving congestion.

# 2.3.4. RailNetEurope (RNE)

RNE was created in January 2004 on the initiative of a number of European railway Infrastructure Managers and Allocation Bodies, who wished to establish a common, Europe-wide organisation to facilitate their international business.

Several business activities in RNE are related to the quality of services in railway transport. One of these activities is, e.g. collecting data about the current position of international trains in relation to timetable and the exchange of these data in real time i.e. already during running train with participating managers infrastructure and carriers. Parts of these logistic processes are the provision of data about estimated train arrival times. The same data is stored in the database and according to the requirements of managers infrastructure are used to create reports and analyses of the accuracy of the movement of trains in international transport.

# 2.4. The background and concept of quality logistics processes applied in terms of railway transport

Railway undertakings and railway organizations are constantly working on the quality and improvement of logistics processes. Methods to improve logistics processes in railway transport are several. Set of ISO standards is a set of standardized procedures and recommendations in the field management of quality.

# 2.4.1. STN EN ISO 9001

The basic technical standard is standard ISO 9001:2015 "Quality Management Systems. Requirements". Certification to ISO 9001 is typically used in private, as well as in public sector to increase confidence in the products and services that provide certified undertaking. It is also used to increase confidence between partners in business, for example, by the choice of suppliers in supply chains. Standard ISO 9001:2015 builds on the foundation of ISO 9001:2009, which specifies requirements for quality management system for demonstration purposes that undertaking is able to consistently provide according to customer requirements. This standard applies process approach management and quality assurance in order to increase customer satisfaction. The requirements for this standard are generally useful in the creation of new logistics processes.

Another important standard is standard STN EN 13816 "Transportation. Logistics and services. Public passenger transport. Service quality definition, targeting and measurement".

# 2.4.2. STN EN 13816

This European standard specifies requirements for defining objectives and measuring quality of service in public passenger transport. Its aim is to use providers services in presentations and monitoring of their services. The main purpose of this standard is to increase the level of quality in the operation of public railway transport, as well as to warn customer needs and expectations by establishing practices in logistics processes that will most likely:

 $\rightarrow$  turn attention to the competent sites

 $\rightarrow$  lead to substantial and deliberate decisions given on to division of competences

 $\rightarrow$  allow customers and other participants of transport market to reliably compare quality of services from different alternative suppliers

 $\rightarrow$  contribute to the introduction of continuous improvement quality of services

# 2.4.3. Regulation (EC) no. 1371/2007 of the European Parliament and of the Council of 23. October 2007 on rail passengers' rights and obligations

Regulation on the rights and obligations of passengers in railway transport was adopted on 23 October 2007 with a view of to ensure basic protection of passengers in railway transport throughout the European Union. The regulation entered into force on 3 December 2009 and applies to all services railway passenger transport (international, national, regional, urban, suburban) in the EU, which provide licensed railway undertakings.

The railway undertakings generally apply regulation relatively effectively. In the report compliance with regulation on the basis of ten fundamental rights passengers in the statement of the rights of passengers in all transport modes is assessed. These rights are no-discrimination, assistance for persons with disabilities or reduced mobility, information, benefits, rerouteing reservation or rebooking, assistance in the event of a stop-over, compensation, responsibility for the carriage of passengers and baggage, complaints handling, implementation and enforcement law. Different methods are used to improve logistics processes in railway transport in addition to technical standards and regulations. The first such method is management method "Total Quality Management".

## 2.4.4. Total Quality Management (TQM)

The concept of TQM came into use in the 1970s for systems enterprise-wide management quality in Japanese undertakings. Gradually, this concept was also inprocess in the American and European business environment. TQM is a new way of thinking that prefers quality over quantity. The common features of this method can be read from its abbreviation:

 $\rightarrow$  T = Total (full participation all employees of railway undertaking)

 $\rightarrow$  Q = Quality (concept principles of quality in whole railway undertaking)

 $\rightarrow$  M = Management (principles cut across all management levels and all management functions).

As defined by the ISO, TQM is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society (ISO, 2014). It is a very comprehensive technology that places emphasis on the quality control in whole dimensions of life railway undertaking. It exceeds the framework of management quality and it also becomes the method of strategic management and management philosophy for the entire conduct undertaking. The basic concept of TQM is focused on the customer, own employees in undertaking, processes, work environment, goals and results, forming the basis of ISO 9001:2000 (Quality management systems - Requirements) and ISO 9004:2000 (Quality management systems - Guidelines for performance improvements).

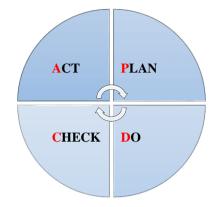
The most important part of TQM are its principles. These principles include: next process is your customer, quality first, speak with data and Deming cycle - PDCA cycle.

# 2.4.5. Deming Cycle - PDCA cycle

Deming stresses the importance of permanent cooperation between research, development, production and sales. To achieve better quality, such a cycle ,which is shown below, should take place permanently.

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# Figure 4. PDCA cycle



Source: Moen, R. & Norman, C.

Process approach is based on the PDCA cycle (plan - do - check - act) as follows:  $\rightarrow$  Plan = set objectives and processes necessary to deliver results in accordance with customer requirements and policy undertaking

 $\rightarrow$  Do = introduce processes

 $\rightarrow$  Check = monitoring and measuring processes, comparing them with politics, objectives and requirements and the subsequent communication of the results

 $\rightarrow$  Act = realization activities for continuous improvement of process performance.

## 2.4.6. Six Sigma

The Six Sigma is a set of techniques and tools for process improvement. It has a positive effect on four central requirements of competition which are quality, time, costs and innovation. As a result, railway undertaking can be better, faster and cheaper slimmer than its main competitor. This method is particularly suitable for undertakings that provide services in innovation.

Six Sigma uses a few basic tools to improve quality of logistics processes and services. Innovations are based on the DMAIC Improvement Cycle that is used for all improvements. It is aimed at finding and removing weaknesses in undertaking. Phases of this cycle include definition, measurement, analysis, improvement and control. Each phase of the entire cycle helps to achieve real improvement of customer services.

## 2.4.7. EFQM Excellence Model (EFQM)

The EFQM is a tool used to help organizations do the aforementioned by measuring where they are on the path to excellence, helping them to understand the gaps and stimulating solutions. The main advantage is its clarity and simplicity in applying new or existing logistics processes. It helps to reveal strengths of undertaking, as well as opportunities for improvement, and encourages solutions in the undertaking. It also allows us to get an independent view on the undertaking and its operation. This model is based on nine criteria: leadership, people, strategy, partnerships and resources, processes (enablers – that which undertaking has) and people results, customer results, society results, business results (results - that, which undertaking achieves). The criteria for this model are very carefully sophisticated in whole railway undertaking, and similar for its surrounding. EFQM emphasizes the ethical principle that is essential for all undertakings.

# 3. REPORT ABOUT COSTS OF QUALITY LOGISTICS PROCESSES IN RAILWAY TRANSPORT

The railway undertakings have based conducted research on defined strategic goals which provide a number of basic goals on the enterprise level in time horizon one year and further specify on the lower organizational levels, i.e. departments, sections or other hierarchically below workplaces (Satanova et al., 2015). In this manner individual goals are divided in all railway undertakings. The results of the research state that classification and identification of costs of quality in respondents railway undertakings is not sufficient. It is based on personal consultation with experts (representatives of railway undertakings) that have expressed a clear need for monitoring and precise classification of costs of this kind.

The result of research is presented in "Report about costs of quality logistics processes in railway transport" which will be monitored in monthly intervals. A summary report about costs of quality will be compiled on an annual basis. Draft report has horizontal and vertical structure, which is depicted in Table 1 and based on the basic formula of calculating costs of quality by Harrington (Nedeliakova et al., 2013, p. 184):

$$N_C = N_I + N_E + N_P + N_H \ [\bullet]$$

where:

$$\begin{split} N_C &- \text{total cost of quality} \\ N_I &- \text{internal cost of quality} \\ N_E &- \text{external cost of quality} \\ N_P &- \text{cost of prevention} \\ N_H &- \text{cost of evaluation} \end{split}$$

Horizontal structure includes planned values of costs, actual values of costs, deviation in one month and cumulative value = deviation in one year. Vertical structure consists of costs of quality divided into internal and external costs, costs of prevention and evaluation. Costs of quality should be adjusted depending on what actual railway undertakings costs to ensure its operation.

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		1	Watch	ning pe	eriod (1			Cumulative value (year)					
Code	Cost item	1000	an		act		ation		an		act		ation
		€	%	€	%	€	%	€	%	€	%	€	%
		N	1 - int	ternal o	costs o	f quali	ty						
N 1.1	Errors employees railway undertaking												
N 1.2	Extra work in removing repairable errors												
N 1.3	Losses from uncorrectable errors												
N 1.4	Losses from faulty equipment railway undertakings												
		N	2 - ex	ternal	costs o	f quali	ity						
N 2.1	Losses from errors other railway undertaking												
N 2.2	Losses from errors external suppliers												
N 2.3	Losses from uncorrectable errors												
			N 3 -	costs c	of prev	ention							
N 3.1	Internal audits												
N 3.2	External audits												
N 3.3	Education and training of employees internally												
N 3.4	Education and training of employees externally												
N 4 - costs of evaluation													
N 4.1	Costs on the test tools											1	
N 4.2	Costs of professional quality assessment												
N 4.3	Costs on the laboratory researches												

Table 1. Report about costs of quality logistics processes in railway transport

Source: authors

Report about costs of quality logistics processes in railway transport will be processed due to increased costs, in the event of different disorders and other stochastic effects such as fire, war, riot, strike of employees railway undertakings, and etc.

# 4. CONCLUSION

The report created in this research highlights the gaps which give rise to higher total costs of railway undertaking. Its use leads every railway undertaking operating on transport market to economic understanding and enables cost reduction which significantly affects quality of services provided. Increased costs of quality arise because of frequent errors on the part of employees of railway undertaking but also employees of external environment. A report is versatile tool that will be worked out separately for each type. Application of this methodology has been practically implemented in various railway undertakings of Europe and it is essential for it to continue in this process through further research and development. The report is prepared by the department of internal audit and serves the purpose of effective cost-cutting logistics processes in railway transport and their prevention.

The railway sector in the European Union has carried out vertical separation of the system. On the one side are infrastructure managers (IM) and on the other side are railways undertakings. For both stakeholders, costs represent driving factor for future development. Further research will focus on the impact of railways undertakings costs with synergy effects associated with logistic processes.

# 5. ACKNOWLEDGEMENT

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# THE CRITICAL PATH METHOD AS THE METHOD FOR EVALUATION AND IDENTIFICATION OF THE OPTIMAL CONTAINER TRADE ROUTE BETWEEN ASIA AND SLOVAKIA

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## Abstract

Containers, as intermodal transport units, not only reduce loading time in sea ports; but they also help to protect cargo against its damage, loss and theft. Nowadays different types of containers are carried by cellular container ships among the continents. In maritime transport there are three main container trade routes that link the developed to developing countries located in Asia, Europe and America. One of these routes links top Asian and European container ports. Vessels, which operate on this route, have to sail through important maritime canals and straits. Some of these places are dangerous because of piracy or local war conflicts.

The goal of this paper is to choose an appropriate method of cargo transport between a selected Asian container port and the Slovak Republic. At the beginning we will describe the container trade route Asia and Europe, Asian and European container ports that handle containers. Then we would like to identify the criteria such as transport time, transport costs, risks during transport which be used for the analysis of the proposed routes. At the end we will use the critical path method, one of the methods of Operation Analysis that will help to evaluate and identify the optimal container route between Asia and Slovakia.

Key words: containers, container trade routes, critical path method, evaluation and identification, maritime transport

## **1. INTRODUCTION**

Most of consumer goods that are sold in the shopping malls come from Asia, especially from the Far East. The developed countries have moved their production subsidiaries to the developing countries of the Far East due to cheap labour force or tax benefits. Most of these goods are transported into containers due to the protection The critical path method as the method for evaluation and identification of the optimal container... Lukáš Hanšút, Andrej Dávid, Jozef Gašparík

of goods against their damage, loss or theft during transport, transhipment and storage and better manipulation of containers in the sea ports (Klapita, 2015; Tengler et al. 2015).

The basic goal of this paper is to focus on transport of containers between Asia and the Slovak Republic and compare it from the different points of view. In the research we have decided to use the critical path method that is one of the methods of operation analysis. Loading of containers will be carried out in the port of Singapore that belongs to the top 20 world container ports. Then, they will be transported by container vessels to four different European ports (Rotterdam, Hamburg, Koper and Constantza), where they will be loaded on the wagons and will be transported to the container terminal Dunajská Streda. We will compare these transport routes from the points of view such as transport time and price.

# 2. THE CURRENT CONTAINER TRANSPORT SYSTEM BETWEEN ASIA AND EUROPE

In 2015 about 175 million TEUs (over 1.69 billion tons of cargoes) were carried by container vessels in the world. In maritime transport there are three main container trade routes that link the continents:

- Transatlantic (North America Europe),
- Transpacific (Far East North America),
- Europe Asia.

One of the busiest routes is the route that lies between Europe and Asia. It links Western Europe (the Netherlands, Belgium, Germany or France) with the Far East (West Malaysia, Singapore, Thailand, Hong Kong, the Philippines, Taiwan, South Korea, China and Japan). Vessels sail from the North Atlantic through the Mediterranean Sea, the Suez Canal, the Red Sea, the Indian Ocean, the Strait of Malacca, and the South China Sea to the North Pacific. On one hand this maritime route is the shortest route between Europe and Asia, on the other hand it is one of the busiest routes in maritime transport (Hanšút, 2015; Černá et al., 2017).

	Trans	Pacific	Europ	oe-Asia	Trans	atlantic
	Eastern Asia- North Americ a	North America -Eastern Asia	Asia- Europ e	Europe -Asia	Europe- North Americ a	North America -Europe
2014	15,8	7,4	15,2	6,8	3,9	2,8
2015	16,8	7,2	14,9	6,8	4,1	2,7
Percentag e change 2014-2015	6,6	- 2,9	-2,2	0,0	5,4	-2,4

**Table 1.** Containerized cargo flows on major east-west (millions of teu)

Source: (Review of Maritime Transport, 2016)

Most of containers are transhipped in the biggest European ports such as the port of Rotterdam or the port of Hamburg. For the countries of Central and Eastern Europe (also for the Slovak Republic) it is better to use the port of Koper or the port of Constantza because these ports are closer to the Asian markets than sea ports of the North Sea. After transhipment of containers in the sea ports they are transported to the container terminals located in hinterland by railway or road transport. We chose the container terminal Dunajská Streda for our comparison because this terminal belongs to the best built terminals in Slovakia. It was built according to the criteria of AGTC.

In spite of the fact containers can also be transported by railway transport from Asia to Europe through the Trans-Siberian railway (this transport route saves transport time about 50 %) most of containers are still transported by ultra large container vessels due to cheaper transport costs (Internal materials of the Ministry of Transport, 2016).

## **3. EUROPEAN MARITIME PORTS**

These days there are about 400 world container ports that handle containers; the top 60 ports handle about 98 per cent of world container port throughput (Grobarčíková & Sosedová, 2014).

The top 20 container ports usually handle about half of the world's container port throughput. In 2015 the list of top 20 container ports included 15 ports from developing economies, all of them were located in Asia. The remaining five ports were from developed countries, three of which were located in Europe (the Netherlands, Belgium and Germany) and two in North America (Los Angeles and Long Beach, California) (Review of Maritime Transport, 2016).

In this part we focused on four European container ports that are important due to transport of containers from Asia to Slovakia.

## 3.1. Port of Rotterdam

The port of Rotterdam is the biggest port in Europe. It lies on the coast of the North Sea and the river Nieuwe Mass. Navigable network of this port is very dense with lots of canals.

The port is largely located in the city centre of Rotterdam, which was caused by historical development of the city. The total length of the port is 42 km. Nowadays, the total area of the port is 12.603 hectares (ha), of which land area is 7.793 ha and water area is 4.810 ha.

Ultra large container vessels and bulk carriers that carry iron ore from Brazil can enter the part called Maasvlakte. Water depth in this part is about 24 metres. The port of Rotterdam is connected with the other world ports through a large number of line companies. The port has got a very good connection with hinterland through road and railway transport (A 15 motorway and railway Betuweroute that links the Netherlands with Germany) (Port of Rotterdam, 2016).

Transhipment and storage of containers is carried out in the different parts of the port of Rotterdam (Maasvlakte, Europoort, Botlek, Eemhaven and Waalhaven).

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Container terminals are divided according to the size of container ships that anchor there. Ultra large container vessels are operated in the container terminals (ECT Delta and Euromax APM or APM 2) that are located in the parts Maasvlakte I and II.

Smaller container vessels are operated in the terminals such as ECT City, RST, Uniport and Barge Center Waalhaven that are situated in the parts Eemhaven and Waalhaven. These ships carry containers between the port of Rotterdam and the United Kingdom / Scandinavian states, respectively between the port and hinterland. The containers are stored in parts Botlek and Waalhaven (Dávid & Jurkovič, 2013).

# 3.2. Port of Hamburg

The port of Hamburg (Figure 1) was the third busiest European port in transhipment of containers in 2015. It is located on the banks of the river Elbe, about 115 km from its estuary into the North Sea. The total area of the port is 7.250 ha, of which land area is 4.331 ha. The maximum allowable draft of vessels is 12.8 metres. In the port bulk, general, liquid cargoes including containers are handled there. The port is directly connected with the hinterland of Germany by road and railway transport. Road transport has the most important role in transport of cargoes between the port and hinterland (about 40 million tons of cargoes are transported by trucks), railway transport links the port with 15 countries. The port area has three main railway stations; the length of railway tracks is about 375 km. The port fills the function of collecting place. The part of containers that are unloaded in the port of Hamburg are transhipped on smaller container vessels. They transport containers to the Scandinavian or Baltic States. It is called feeder service. In the port there are four container terminals (Altenwerder, Burchadkai, Eurogate and Tollerot), two of them use automated handling devices in their handling systems (Port of Hamburg, 2016).



Figure 1. Port of Hamburg and its container terminals

Source: (Port of Hamburg, 2016)

# 3.3. Port of Koper

The Slovenian port of Koper is located in the northern part of the Adriatic Sea. It links the countries of Central and Eastern Europe with the Asian and African countries. This port is intermodal centre; there are used different transport and loading systems such as RO-RO technology, handling devices for transhipment of different types of bulk, general and liquid cargoes (oversize cargo, containers, cars, livestock, and raw materials) (Port of Koper, 2016).

The port of Koper has got 11 special terminals (Figure 2) which carry out various functions such as transhipment and storage of cargoes, and different additional services. Each terminal is equipped by transhipment; shipping and storage technology. Container terminal that is located in the southern part of the port is equipped by cranes Panamax and Post Panamax. It has got four berths where vessels anchor during transhipment of containers. The port of Koper has got a good connection with other modes of transport. Rail transport conveys about 70 % of cargoes, the rest is transported by road transport (Port of Koper, 2016).

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Figure 2. Port of Koper and its terminals

The Port of Koper has an important role for import of the spare parts located into the containers from South Korea to the automobile factories KIA and Hyundai located in Slovakia and the Czech Republic. About 140 000 TEUs (1 250 000 tons of cargoes) are imported by ships every year, twice a week (Twrdy et al., 2012).

# 3.4. Port of Constantza

The Port of Constantza (Figure 3) that is the biggest Romanian port is located on the western coast of the Black Sea, 179 nautical miles (nm) from the Bosporus Strait

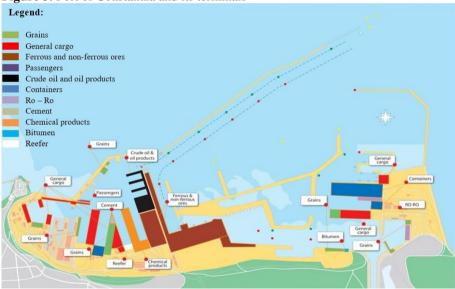
Source: (Port of Koper, 2016)

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and 85 nm from the Sulina Branch. It covers 3.926 ha, of which land area is 1.313 ha and water area is 2.613 ha. The total quay length is 29, 83 km. The maximal allow draught for vessels is 19 metres. The port is part of the Romanian maritime port system under the coordination of Maritime SA Constantza. The south part of the port is linked with the Danube River by the Danube-Black Sea Canal. There are also located river port and Ro-Ro terminal and container terminal. In river port cargoes are loaded on inland vessels (barges, motor cargo vessels) that transport them to hinterland of Romania or other Danube countries. Constantza South Container Terminal was put in the operation in 2004. This terminal is equipped by container gantry cranes that tranship containers between the terminal and container vessels Panamax or Post Panamax. It provides the standard services such as other world container terminals (Port of Constantza, 2016).

The Port of Constantza has got a good connection. The rail network of the port that is about 300 km long, is connected with the Romanian and European rail network. The Port is an important part of TRACEA corridor that provides connection between Europe, Caucas and the Middle East. The Port of Constantza (Figure 3) became Free Zone in January 2007. It allows operating all types of cargoes.

## Figure 3. Port of Constantza and its terminals



Source: (Port of Constantza, 2016)

# 4. THE POSSIBILITIES OF TRANSPORT CONTAINERS BETWEEN ASIA AND SLOVAKIA AND THEIR COMPARISON

During the proposal of a suitable way for transport of containers between the Slovak Republic and Asia (the Far East) we focused on the aspects which influenced mainly on transport processes that were carried out by sea and railway transport. Containers are mainly transported by sea transport between the continents. In this part we analysed possible transport routes between Asia and Europe and four maritime ports that are important for Slovakia. After containers were unloaded in one of the ports they were transported by railway transport to the container terminal Dunajská Streda in Slovakia. We used the critical path method (CPM) for the comparison and selection of the optimal transport route (Hanšút, 2015).

The critical path method (CPM) is one of the basic deterministic methods of network analysis. Its goal is to determine the duration of a project based on the length of the so-called critical path, which is the sequence of interdependent activities with the least time reserve. CPM enables to facilitate effective time coordination of the partial inter-related activities of the project.

The critical path is defined as the longest possible path from the starting point to the endpoint of the graph. Each project has got at least one critical path. Each critical path consists of a list of activities which the project manager should focus on if he / she wants to ensure timely completion of the project. The end date of the last task on the critical path is also the completion date of the project.

If the duration of the activities is not known with certainty, the Program Evaluation and Review Technique (PERT) can be used to estimate the probability that the project will be completed by a given deadline (Winston, 2004; Fan et al., 2016).

# 4.1. Singapore – Rotterdam - Dunajská Streda

Between the port of Rotterdam (Europe) and Singapore (Asia) there are five transport routes (Figure 4). One of limiting elements for choosing the best transport route is transport time that depends on the length of transport route and the speed of vessel that is 15 knots (kn).

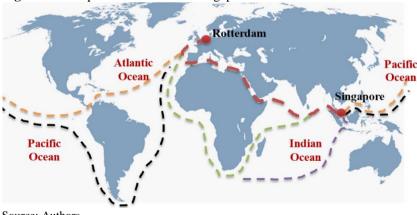


Figure 4. Transport routes between Singapore and Rotterdam

Source: Authors

The shortest route from the point of time is the route that passes through the Strait of Malacca, the Indian Ocean and the Red Sea, the Suez Canal, the Mediterranean Sea, the North Atlantic and the North Sea. Transport time is about 23

days (Table 2). The price for transport of one TEU is 612 EUR. This price also includes charges for bunker adjustment factor, terminal handling charge, seaway bill, seal and report of goods in advance. We chose APL, one of the world's leading ocean carriers, for transport of containers (Hanšút, 2015).

Route	Distance (km)	Vessel speed (nautical miles/hour)	Time (days / hours)
Suez Canal	15 349	15	23/1
Cape of Good Hope	21 770	15	32/16
Panama Canal	28 400	15	42/14
Strait of Magellan	31 295	15	46/23
Cape Horn	31 414	15	47/3

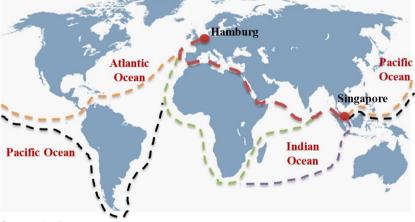
 Table 2. Maritime transport between Singapore and Rotterdam

Source: (Sea Distances, 2016)

After arrival of the container ship in the port of Rotterdam containers are transhipped on railway wagons. The whole handling process takes about 36 hours. Then, they are transported by railway transport from the Netherlands through Germany, the Czech Republics to the terminal Dunajská Streda located in the Slovak Republic. The total length of this transport route is 1 515 km and takes about 32 hours and 9 minutes. The price for transport of one TEU is 800 EUR (Hanšút, 2015).

# 4.2 Singapore – Hamburg - Dunajská Streda

Figure 5. Transport routes between Singapore and Hamburg



Source: Authors

As in the previous case the shortest maritime route between Singapore and the port of Hamburg leads through the Strait of Malacca, the Indian Ocean and the Red Sea, the Suez Canal, the Mediterranean Sea, the North Atlantic and the North Sea (Figure 5). This voyage takes about 23 days 17 hours (Table 3); the speed of the vessel

is 15 kn. The price for transport of containers is 612 EUR and includes all charges as in the previous case. We chose the same carrier for transport of containers as in the previous case. In the case we chose another route transport time would be prolonged at least 10 days (Hanšút, 2015).

Route	Distance (km)	Vessel speed (nautical miles/hour)	Time (days / hours)
Suez Canal	15 818	15	23/17
Cape of Good Hope	22 239	15	33/9
Panama Canal	28 869	15	43/7
Strait of Magellan	31 764	15	47/15
Cape Horn	31 882	15	47/20

**Table 3.** Maritime transport between Singapore and Hamburg

Source: (Sea Distances, 2016)

After arrival of the container ship in the port of Hamburg containers are transhipped on railway wagons. The whole handling process takes about 22 hours. Then, they are transported by railway transport from Germany through the Czech Republics to the terminal Dunajská Streda located in the Slovak Republic. The total length of this transport route is 1.053 km and takes about 30 hours and 9 minutes. The price for transport of one TEU is 650 EUR. (Hanšút, L., 2015)

# 4.3 Singapore - Koper - Dunajská Streda

In this case we also chose the shortest transport route between the ports. It leads through the Strait of Malacca, the Indian Ocean, the Red Sea, the Suez Canal, the Mediterranean and Adriatic Sea (Figure 6).

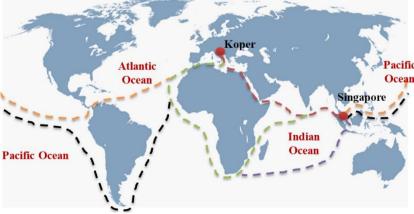


Figure 6. Transport routes between Singapore and Koper

Source: Authors

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The port of Koper that is the part of NAPA (North Adriatic Ports Association) has got a very good position. Transport time (Table 4) between this port and the ports of the Far East is at least one week shorter than between the ports of the North Sea (the port of Rotterdam, the port of Hamburg) and the ports of the Far East. The price for transport of containers is 1.236 EUR on this route. We chose the maritime carrier Evergreen for this transport (Hanšút, 2015).

Route	Distance (km)	Vessel speed (nautical miles/hour)	Time (days / hours)
Suez Canal	11 675	15	17/12
Cape of Good Hope	22 832	15	34/6
Panama Canal	30 564	15	45/20
Strait of Magellan	32 388	15	48/14
Cape Horn	32 503	15	48/18

Table 4. Maritime transport between Singapore and Koper

Source: (Sea Distances, 2016)

After arrival of the container ship in the port of Koper containers are transhipped on railway wagons. The whole handling process takes 29 hours. Then, they are transported by railway transport from Slovenia through Hungary to the terminal Dunajská Streda located in the Slovak Republic. The total length of this transport route is 660 km and takes about 24 hours. The price for transport of one TEU is 350 EUR (Hanšút, 2015).

# 4.4 Singapore - Constantza - Dunajská Streda

In this case we also chose the shortest transport route that leads through the Strait of Malacca, the Indian Ocean, the Red Sea, the Suez Canal, the Mediterranean and Black Sea (Figure 7).



Figure 7. Transport routes between Singapore and Constantza

Source: Authors

The port of Constantza has a very good position due to saving of transport time. It is at least one week shorter than between the ports of the North Sea and the ports of the Far East (Table 5). The price for transport of containers is 723 EUR. We chose the maritime carrier Blue Anchor America Line for this transport. (Hanšút, 2015). **Table 5.** Maritime transport between Singapore and Constantza

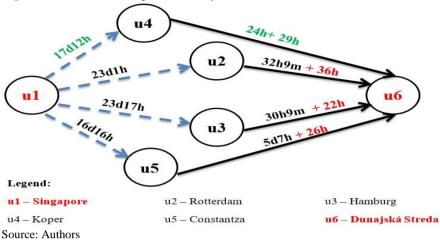
Route Distance (km)		Vessel speed (nautical miles/hour)	Time (days / hours)
Suez Canal	11 105	15	16/16
Cape of Good Hope	23 483	15	32/5
Panama Canal	32 216	15	46/20
Strait of Magellan	33 040	15	49/13
Cape Horn	33 155	15	49/17

Source: (Sea Distances, 2016)

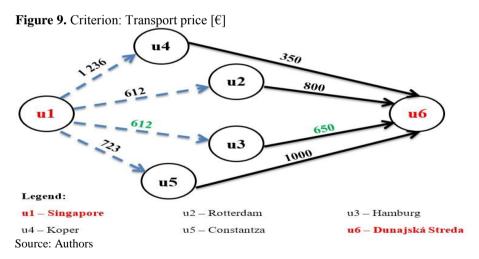
After arrival of the container ship in the port of Constantza containers are transhipped on railway wagons. The whole handling process takes 26 hours. Then, they are transported by railway transport from Romania through Hungary to the terminal Dunajská Streda located in the Slovak Republic. The total length of this transport route is 1.226 km and takes 5 days and 7 hours. The price for transport of one TEU is 1.000 EUR. (Hanšút, L., 2015)

# 5. COMPARISON PROPOSED VARIANTS

We decided to use the CPM for the determination of optimal transport route between Singapore and Dunajská Streda. Each transport route was evaluated according to total transport time. The shortest transport route would pass through the Suez Canal and the port of Koper and would take 19 days and 17 hours (Figure 8), (Table 6). On the other hand the longest one was the route that passed through the port of Rotterdam or the port of Hamburg. In both cases it was 25 days and 21 hours (Hanšút, 2015). The critical path method as the method for evaluation and identification of the optimal container... Lukáš Hanšút, Andrej Dávid, Jozef Gašparík



For the part of customers transport price is sometimes more important than transport time. From the point of view of transport price the cheapest transport route passed through the port of Hamburg (Figure 9). The total price for this route was 1.262 EUR for 1 TEU. On the other hand the most expensive route was the route that passed through the port of Constantza that was 1.723 EUR for 1 TEU (Hanšút, 2015).



The comparisons of transport routes from different points of view are presented in the table 6.

Criterion	Transport route of maritime transport	Value of criterion	Transport route of rail transport	Value of criterion	Total
e rt	SGP - RTM	15 349 km	RTM - DS	1 515 km	16 864km
spo	SGP - HAM	15 818 km	HAM - DS	1 053 km	16 871km
Transport distance	SGP - Koper	11 675 km	Koper - DS	660 km	12 335km
E -	SGP - CT	11 105 km	CT - DS	1 226 km	12 331km
t	SGP - RTM	23d 1h	RTM - DS	2d 2h 9m	25d21h9m
anspo time	SGP - HAM	23d 17h	HAM - DS	2d 4h 9m	25d21h9m
Transport time	SGP - Koper	17d 12h	Koper - DS	2d 5h	19d17h
E	SGP - CT	16d 16h	CT - DS	6d 9h	23d 1h
rt	SGP - RTM	612€	RTM - DS	800€	1 412 €
<b>Transport</b> price	SGP - HAM	612€	HAM - DS	650€	1 262 €
l'rai	SGP - Koper	1 236 €	Koper - DS	350€	1 586 €
F	SGP - CT	723€	CT - DS	1000€	1 723 €

 Table 6. Table of results

Source: Authors

# 6. CONCLUSION

The critical path method can be used as a tool for the estimation of the duration of a project. It is applied for the projects where durations can be estimated with a high degree of accuracy. The durations are usually known according to past experience and knowledge of the data of previous projects. It means that the durations are not statistically determined. This type of method can be used in logistics and transport.

In our research that was focused on the evaluation of the optimal transport route between the Singapore and Dunajská Streda from the point of duration we found out that the shortest route would go through the Suez Canal and the Slovenian port of Koper and it would take less than 20 days.

However, a lot of customers prefer transport price to transport time. According to our calculation that we did, the cheapest route was the route that led through the port of Hamburg.

At the end everything depends on the decision that the customer will make. If he / she prefers transport time to transport costs or vice versa.

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# UNMANNED AIRCRAFT SYSTEMS IN LOGISTICS – LEGAL REGULATION AND WORLDWIDE EXAMPLES TOWARD USE IN CROATIA

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## Abstract

Business logistics is important for delivering products in time, without damage and with the lowest possible costs. With current technology developments, there are many ideas and projects about how to reach this goal. One of these developments includes unmanned aircraft systems (UAS) - widely known as drones, for use in logistics as a tool to deliver products to their final users.

The use of unmanned aircraft systems is not new and they are presently used for different applications worldwide, from military purposes to filming and crop control. Recently the idea about using drones in logistics has been tested by different logistics companies for different purposes, from last mile deliveries of ordered products to deliveries from fast food restaurants. Due to this the question arises - can it be done in Croatia? If yes, by whom, and for what purposes in logistics?

This paper will provide a definition of unmanned aircraft systems and present various applications thereof, as well as the types currently used throughout the world. Since unmanned aircraft systems are starting to become a part of logistics, different examples of drones' use in logistics worldwide are presented. We will analyse legal regulation in Croatia, possible problems, and will also consider who could be potential users of unmanned aircraft systems in logistics, either for last mile deliveries or for some other purpose. In conclusion, we will propose further research in this field and how it may influence further development of business logistics

**Key words:** unmanned aircraft systems, drones, legal regulation, logistics, Republic of Croatia

## **1. INTRODUCTION**

Business logistics is considered as a part of supply chain, which includes inventory management, transportation and distribution. Due to its importance, business logistics is part of management in every company, regardless of whether it is a manufacturing or service company. This importance is stressed further because logistics creates value for customers and suppliers of the firm, and value for the firm's stakeholders (Ballou, 1997: 118). Although the marketing system of business logistics also encompasses the consideration of profit, business logistics has the same idea as modern military logistics (Ito, 2016). This means that besides the efficiency in transporting things, mobility is also common Drones were put into practice in military but they also have potential in other areas of use, one them being business logistics. A statement by Amazon CEO Jeff Bezos that drone delivery will be as normal as seeing mail trucks (O'Brien, 2015) shows that change is coming to business logistics. This statement is confirmed by research conducted by The Material Handling Institute (Deloitte, 2015) about the future of supply chain technology. The findings showed the importance of driverless vehicles and/or drones as emerging technologies that will play an important part in the supply chains of future.

The aim of the paper is to investigate the legislation and potential for drone use in business logistics in Croatia. The paper gives an overview of the term unmanned aerial vehicle. Different types and applications of drones are presented and explained. The third section examines legal regulation of drone usage in Europe and Croatia. The paper presents global examples of different uses of drones for deliveries of fast food orders, mail, or for last mile delivery. It looks upon current and potential use of drones in Croatia. Finally, the paper provides implications for further research of the use of drones for last mile delivery of goods and their potential impact on business logistics in Croatia.

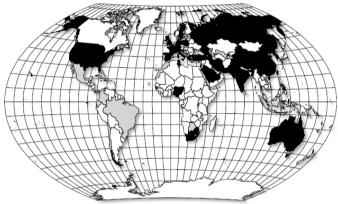
## 2. UNMANNED AERIAL SYSTEMS - DRONES

Since the first airplane and the Wright brothers, there was an idea of unmanned aerial systems, and this was a huge challenge for engineers and scientists. The first unmanned aircraft (balloons filled with explosive content) were used by the Austro-Habsburg Empire in 1849 during their attack on Venice (Consortiq, 2016). History remembers the Wright brothers' airplane from 1916 and the drones used by the British Navy for target practice from 1933 (Gonzalez-Aguilera and Rodriguez-Gonzalvez, 2017). To have and to control an aircraft without a pilot was always a huge challenge, both from the military and civilian standpoint.

When speaking of drones in the European context, it should be noted that there is no established terminology that regulates this matter. The current nomenclature for unmanned civilian or military aircraft is varied: drone, unmanned aerial vehicle (UAV), unmanned aircraft system (UAS), remotely piloted aircraft system (RPAS) or aircraft (RPA). The terms RPAS and RPA refer to the rules set by ICAO, and ICAO does not use the term 'drone'. To avoid confusion, including concerns about liability and insurance, it would be advisable to work towards using the ICAO terminology in the European context. In accordance with the Commission communication, the term UAV is used to mean an unmanned, autonomously functioning aircraft. An RPAS is an aircraft controlled remotely by a third party. The term 'drones' is now firmly established in public parlance for all types (European Parliament, 2014: 90). A drone can be defined as an aircraft without a human pilot on board (Estampe, 2015: 15).

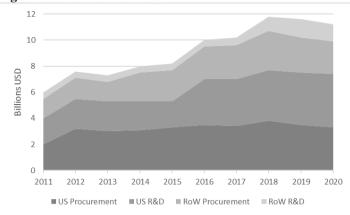
Previously, drones were mainly connected to the military, where they were used largely for two purposes: reconnaissance and surveillance, and ground attacks. The use of drones has many benefits based on their flight system (either remotely controlled or autonomous) and their sensory system needed to attain precise positioning information and a great variety of data. The number of developed types of drones has been significantly increased recently, and their use has been moving away from military to civilian purposes (Figure 1)

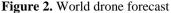
Figure 1. Global trends in UAV proliferation

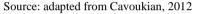


Source: adapted from Horowitz and Fuhrmann, 2015

Black areas are countries that are developing armed UAV programs, while grey areas represent countries that are developing unarmed UAV capabilities. It is important to state that the proliferation of drones is still poorly understood (Horowitz & Fuhrmann, 2015) and that it is today's reality for regulators, start-ups, policy makers (local, regional, national) and companies around the world. Purchase of drones and investments in their research and development will continue to grow in the next years (Figure 2).







Another study (Finnegan, 2015) predicts that the value of the worldwide production of drones will grow from current 4 billion USD/year to 14 billion USD/year within the next ten years. Based on current and future developments in drone R&D and potential areas of use, the main advances of drones can be seen in (1) the emergence of new sensors that allow the improvement of the geometric and radiometric resolution, as well as the spectral range; (2) the evolution of new platforms that improve robustness and increase autonomy; (3) the development of software, from the navigation and communication with the platform to the processing and analysis of the images captured; (4) new applications in emerging sectors: logistics, disaster assistance, security and surveillance, health and marine science, among others (Gonzalez-Aguilera and Rodriguez-Gonzalvez, 2017: 1). UAV market today is mainly intended for military applications (72%), followed by consumer (23%) and civilian applications (5%). The most rapid growth is predicted for civilian application of UAVs, but application in this sector is starting from a very low base (Finnegan, 2015). Since the UAV civil and commercial market is still in its incipient phase, there is a significant potential and a potentially wide range of applications where UAVs can be used to replace current solutions or be used in areas where there are no existing solutions (European Commission, 2007).

## 2.1. Types of UAVs

Today, there are many different types of UAVs available on the market for commercial and civilian purposes. Generally, UAVs are usually classified according to measurements or specifications, which are not only related to endurance or range, but also to price, maximum take-off weight, the engine used, and price. Thus, there are possible categorizations of drones based on their range (short or long), price (expensive or inexpensive), payloads (high or low), complexity of models (complex or non-complex), number of blades (quadcopter, octocopter, multicopter), etc. Heutger (2014) and Kelek (2015) divide UAVs based on build type into several groups: fixed-wing, tilt-wing, unmanned helicopter and multicopter, which are known mostly as drones (Table 1).

Types	Advantages	Disadvantages	Example
Fixed wing	Long range Endurance	Horizontal take- off, requiring substantial space or support Inferior maneuverability compared to VTOL (Vertical Take-Off and Landing)	Taba and the second secon
Tilt wing	Combination of fixed wing and VTOL advantages	Expensive Technology complex	A A
Unmanned Helicopter	VTOL Maneuverability High payloads possible	Expensive Comparably high maintenance requirements	
Multicopter	Inexpensive, Low weight Easy to launch	Limited payloads Susceptible to wind due to low weight	

**Table 1.** Advantages and disadvantages of different types of UAVs

Source: adapted from Heutger, 2014 and Kelek, 2015

Another possible categorization of UAVs is into three groups: rotary wings, fixed wings and lighter than air. This categorization looks upon launching capabilities, areas needed for manoeuvring, speed, endurance, load capacity and altitude capability. Each of these groups have their own advantages and disadvantages, but they all have enormous potential in the future for all different applications UAVs can be used for.

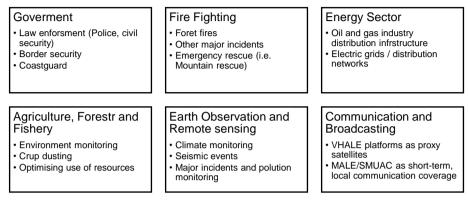
# 2.2. Application of drones

With increased demand and production, the drone market is being accepted by a growing number of different industries. The drone market is predicted to see significant growth in the media and entertainment industry (Global Market Insights,

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2016). Civil and commercial market applications of drones can be divided in several different ways (Figure 3).

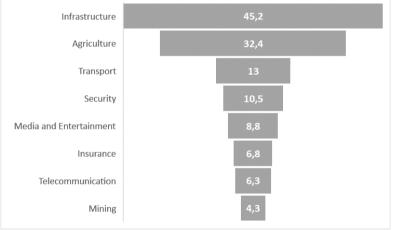
Figure 3. Civil and commercial drones market segmentation



Source: adapted from Frost & Sullivan, 2007: 7

The importance of different drone applications can be seen in the value of businesses and labour in different industrial sectors which can use drones (Figure 4).

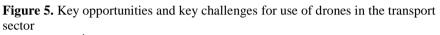
Figure 4. Value of drone powered solutions addressable industries (in billions USD)

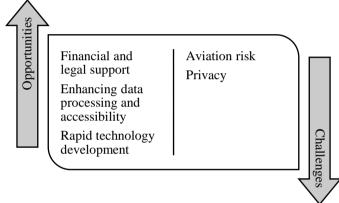


Source: adapted from Mazur & Wisniewski, 2016: 4

The total drone powered solutions value in presented industrial sectors is more than USD 127 billion. The highest potential for the application of drones is in infrastructure (railways, roads, energy, and oil & gas) with a total value of USD 45 billion (Mazur & Wisniewski, 2016). Other sectors in which drones have or will have significant use are: insurance, media and entertainment, telecommunications, agriculture, security, and mining.

In the transport sector, development projections for the use of drones are admirable due to technology improvements, which are seen every day. Although drones were not seen as an integral part of the transport industry, nowadays the transport sector uses drones for their accessibility, cost of operations and their speed compared to other transport choices. The main areas for drone use in transport are parcel deliveries, spare parts deliveries, food delivery, and medical logistics. Since drones and helicopters are very much similar, it is possible to predict that some operations currently performed by helicopters will be performed by drones in the future (Smith, Mazur & Wisniewski, 2017). Further use in the transport sector faces several key opportunities and key challenges (Figure 5).





Source: adapted from Smith, Mazur & Wisniewski, 2017: 12

The key opportunities for further drone use in the transport sector are in finding financial and legal support (like Israeli and Chinese governments do for their drone industries) and to continue with rapid technology development, which leads to lower prices of final products – drones. The key challenges primarily include the issue of safety, where it is needed to develop complex air management systems to prevent possible air collisions, and secondly, the issue of privacy, since drones fly over various types of sites and collect a massive quantity of information, and currently there is no regulation regarding the collected data. Additionally, Rosenberg (2009) stated several significant market barriers for commercial and civil application of drones: (i) lack of operator training and safety standards; (ii) limited payload capacity and space restrictions; (iii) no secure non-military frequencies; (iv) liability for civil operations; (v) incomplete or immature air space regulations that encompass UAV systems; (vi) negative consumer perception.

# **3. LEGAL REGULATION**

With the advancement of technology, the ever-increasing use of drones is becoming more and more common. To date, most flights conducted by drones have taken place in segregated airspace to avoid danger to other aircraft. Drones are increasingly being used in the EU, but under a fragmented regulatory framework, since each Member State has its own rules. So far, only a few countries, including the Republic of Croatia, have legally regulated this area, but due to unexplored possibilities and constant progress of unmanned aircraft, this area will need to be constantly upgraded and legally regulated. In May 2015, the Republic of Croatia adopted the Ordinance on unmanned aircraft systems (Official Gazette, 49/2015, 77/2015).

Country	Possibility of commercial flights	License required to fly	Possibility to perform BVLOS flights	License required for BVLOS flights	Insurance required for commercial flights	Training required for pilots to obtain license
Poland	~	~	~	~	~	<b>~</b>
UK	>	~	>	~	~	>
China	~	$\checkmark$	~	×	<ul> <li>✓</li> </ul>	$\checkmark$
Canada	~	<ul> <li></li> </ul>	~	×	>	>
Germany	~	<ul> <li></li> </ul>	×	×	>	>
France	~	<ul> <li></li> </ul>	~	×	×	>
South Africa	~	~	~	×	×	~
Indonesia	~	~	×	×	~	~
Australia	~	~	×	×	~	~
Brazil	~	~	~	×	×	X
Mexico	~	<ul> <li></li> </ul>	×	×	×	>
USA	~	~	×	×	×	X
Japan	~	X	×	×	×	X
Russia	×	×	×	×	×	>
Argentina	X	×	X	×	×	×

**Table 2.** Regulation by country

Source: adapted from Mazur & Wisniewski, 2016: 21

The legal issues of drones are regulated at three levels: international, European and national (Croatian) (Table 2). Solving this legal issue is initiated through work of **International Civil Aviation Organization (I**CAO), European Aviation Safety Agency (EASA) and Croatian Civil Aviation Agency (CCAA), but also includes the European Organization for the Safety of Air Navigation (EUROCONTROL), Joint Authorities for Rulemaking on Unmanned Systems (JARUS), etc.

Observing the international regulation, it should be emphasized that according to Article 8 of the Convention on International Civil Aviation (ICAO, 1944) *no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in*  accordance with the terms of such authorization. Each contracting State undertakes to ensure that flight of such aircraft without a pilot in region open to civil aircraft shall be so controlled as to obviate danger to civil aircraft. In accordance with the above-mentioned, European countries are increasingly adopting ordinances governing the legal framework for the implementation of UAS flight operations. Most of the adopted legal frameworks regulate this matter in a similar way, and differ according to the categories of unmanned aerial vehicles, the areas above which flight operations are performed, the conditions for flying operations, etc. (Mudrić & Katulić, 2016: 126). It must be mentioned that ICAO has published Circular 328 (2011) on Unmanned Aircraft Systems (UAS) and amended Annexes 2, 7 and 13 to the Chicago Convention to accommodate Remotely Piloted Aircraft Systems (RPAS) intended to be used by international civil aviation (EASA 2015b).

The development of unmanned aircrafts has started a new chapter in the history of air transport. The current situation, regarding drone regulation in the EU is not fully satisfactory since legislation in Member States is not harmonized and there is no obligation of mutual recognition of certificates or authorizations. An unmanned aircraft operator authorized in one Member State must obtain another authorization in another Member State if they want to operate there. Furthermore, current EU legislation assumes that unmanned aircraft below 150 kg are operating locally. However, there are small unmanned aircraft that can fly very high or can operate at long distances, which could affect several Member States and thus need multiple authorizations. For that reason, the Commission has proposed, under the 2015 EU Aviation Strategy, to create a risk-based framework for all types of drone operations, which will ensure the safe use of drones in civil airspace and create legal certainty for the industry. Concerns related to privacy and data protection, security, liability and insurance or environment will also be considered (European Commission, 2017).

The Commission works together with the EASA. Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (Text with EEA relevance) (European Commission, 2008), known as Basic Regulation (European Parliament, 2008) mandates the EASA to regulate UAS and RPAS, when used for civil applications and with an operating mass of 150 kg or more. Experimental or amateur-built RPAS, military and non-military governmental RPAS flights, civil RPAS below 150 kg, as well as model aircraft, are regulated by individual Member States of the European Union.

The current division of competence between Union and Member States regarding regulation of unmanned aircraft, which is based on a threshold of 150 kg, is generally deemed obsolete. The rules for unmanned aircraft should evolve towards an operation centric approach, where risk of an operation is made dependent on a range of factors (European Commission, 2015:7).

European Commission published the Proposal for a Regulation of the European Parliament and of the Council on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008 of the European Parliament and of the Council, COM (2015) 613 Unmanned aircraft systems in logistics – legal regulation and worldwide examples towards use... Aleksandar Erceg, Biljana Činčurak Erceg, Aleksandra Vasilj

final (2015/0277 (COD), which prescribes new demands based on past experiences and problems encountered.

Aviation safety is the main objective of the European Commission's (2015) proposal, but it is also a part of a larger context - fostering jobs and growth, developing the internal market. Unmanned aircraft manufacturing has a cross-border dimension, since many unmanned aircraft are bought online, are imported or at least have imported parts. Mutual recognition in the internal market is difficult to achieve in the presence of detailed and diverging national standards and rules. In addition, many operators are developing cross-border activities, so they should be able to use the same unmanned aircraft and the same operating requirements with the same pilot at different places in the Union to develop their businesses. Large delivery companies have expressed their intentions to organize their services at European level, which requires common rules. (European Commission, 2015:4).

The Proposal contains provisions (Articles 45-47) that create the legal basis to provide for more detailed rules on unmanned aircraft. Annex IX of the Proposal contains the essential requirements concerning the design, production, operation and maintenance of unmanned aircraft that need to be complied with to ensure safe operations.

These provisions bring legal certainty to this rapidly expanding industry that includes many small and medium-size enterprises and start-ups. For safety reasons, all drones are covered, from small 'toys' to large unmanned aircraft. As risks arising from drone operations vary, the rules should be proportionate and *consider the extent* to which other air traffic or people on the ground could be endangered. Higher-risk operations will require certification, while drones presenting the lowest risk would just need to conform to the normal EU market surveillance mechanisms (European Council, 2016).



Figure 6. Aviation operations - today and future

Source: adapted from European Commission, 2017a: 3-4

EASA published a Technical Opinion (EASA, 2015a) that does not include new draft legal text beyond the one that has been proposed by the Aviation Strategy. Its purpose is to lay the foundation for future work, illustrate the contents of the draft changes to the Basic Regulation and serve as guidance for Member States (MS) to develop or modify their regulations on unmanned aircraft. It includes 27 concrete proposals for a regulatory framework and for low-risk operations of all unmanned aircraft irrespective of their maximum certified take-off mass (MTOM). The EASA

also produced 'prototype' regulation (supplemented by an Explanatory note) in 2016 that presents a 'prototype' regulation for to the operation of unmanned aircraft in the 'open' and 'specific' categories and its purpose is to inform and consult stakeholders in view of the ongoing negotiations on the review of Regulation (EC) No 216/2008 and in view of giving indications on the possible direction that EASA will take on its implementation (EASA, 2016).

We can say that although there are obvious efforts to bring a suitable legal framework for drones at EU level, it is obvious that this job will be difficult and longlasting. All civil aviation activities carried out on the territory and in the airspace of the Republic of Croatia are regulated by the Air Traffic Act (Official Gazette, No. 69/2009, 84/2011, 54/2013, 127/2013, 92/2014). Air Traffic Law prescribes in Article 93a that conditions for the safe use of unmanned aircraft, unmanned aircraft systems and model aircraft, as well as the conditions to be met by persons involved in the management of these aircraft and systems are determined by a special regulation. Based on this provision, the Ordinance on unmanned aircraft systems was adopted in 2015.

In accordance with Article 2, point 2 of the Ordinance, an unmanned aircraft is an aircraft intended for the operation without a pilot in aircraft, which is either remote controlled or programmed and autonomous, and the term unmanned aircraft system (UAS), according to point 13, is a system designed to perform flights with aircraft without a pilot that is remote controlled or programmed and autonomous. It consists of unmanned aircraft and other control or programming components necessary for the control of unmanned aircraft, by one or more persons.

The provisions of the Ordinance, in accordance with Article 1, paragraph 2, shall apply to unmanned aircraft systems, with operating mass up to and including 150 kilograms that are used in the Republic of Croatia. The provisions of the Ordinance, pursuant to Article 2, paragraph 3, shall not apply to unmanned aircraft systems when they are used for state activities (military, police, security intelligence, customs, search and rescue, firefighting, coastal guarding and similar activities or services).

With regard to operating mass, unmanned aircraft, according to Article 3 of the Ordinance, are divided into three classes. In Article 4, the Ordinance clearly defines the classification of flight areas in relation to buildings, population and presence of people. The flight operations category is determined by the level of risk that their performance represents for the environment, in accordance with Annex 1 of the Ordinance (Table 3).

	Area of flight performance class					
Unmanned Aircraft	Ι	II	III	IV		
System Class	Unbuilt	Built uninhabited	Inhabited	Highly		
	area	area	area	inhabited area		
Class 5 OM* < 5kg	А	А	В	С		
Class 25 $5 \le OM < 25 \text{ kg}$	А	В	С	D		
Class 150 $25 \le OM \le 150 \text{ kg}$	В	С	D	D		

Table 3. Flight Operations Categories

Source: Ordinance on unmanned aircraft systems, Annex I., 2015 \*OM – operating mass of an unmanned aircraft

Regarding the safety of flying, Article 11 of the Ordinance prescribes general conditions for flying unmanned aircraft. Flight must be performed in a manner that does not represent a danger to life, health, or property of people due to impact with a surface or due to loss of control over UAS and that does not endanger or interfere with public order, and this must be ensured by the operator. Some provisions from Article 11, paragraph 2 will in practice lead to the greatest restrictions on the use of unmanned aircrafts.

One of the most problematic provisions is the one on flight performance during daylight (Article 11, paragraph 2, point a) because it prevents full exploitation of the technological capabilities of unmanned aircraft. This is especially true in cases of night-time recording, delivery, protection and rescue, etc. It has already been suggested that under such strict conditions and with the use of additional night-time equipment, such night flights could be performed. As Mudrić and Katulić (2016: 137) cited, the CCAA has concluded that performing UAS flight operations at night is not a reliable and safe way to conduct UAS flight operations, and has rejected such proposal.

Article 11, paragraph 2, points f), g), h) and j) prescribe flight distances from certain objects: from humans, animals, buildings, vehicles, vessels, other aircraft, roads, railways, waterways or transmission lines – not less than 30 meters during the flight; from a group of people – minimum 150 meters; unmanned aircraft flight takes place within the operator's visual line of sight and at a distance of not more than 500 m from the operator; unmanned aircraft flight takes place at a distance of at least 3 km from the airport. However, Article 14 of the Ordinance predicts some exceptions to these provisions, so that flight operations (which are performed in a way different than the one prescribed in Article 11, paragraph 2, points f), g), h) and k)) exceptionally can be performed if the operator has previously obtained the approval of the Agency, and in the case from point i) (that an unmanned aircraft flight takes place outside the controlled airspace) if it obtains approval for the special use of airspace from the competent air traffic control.

As one of the problems of UAS, we can mention the fact that we do not have an UAS registry, which should be implemented based on comparative legal solutions. As Mudrić and Katulić (2016: 147) cited, UAS registries or registries of operators of UAS flight operations are present in legal frameworks for performing UAS flight operations in the Czech Republic, Italy, the Netherlands and Sweden.

Although Annex 5 of the Ordinance provides the fulfilment of certain requirements relating to flight operations, relating to the age of the operator, the psychophysical ability, knowledge of the aviation regulations and ability to manage the system depending on the category of flight operations, they are not strict; therefore, questions concerning the safety of performing such flights as well as issues related to liability for damage in correlation with the sufficient ability of the operator of flight operations are raised. These problems should be considered in the following revisions or amendments of the Ordinance, especially if one considers that changes to the legislation envisaged at the European level will certainly be necessary.

## 4. DRONES IN LOGISTICS – WORLDWIDE EXAMPLES

Drones in logistics are being tested for last mile deliveries of parcels. Last mile delivery is considered as the last part of the supply chain and *as the most inefficient due to its specificities such as a spatial distribution of relatively small receiving points, demands for more frequent but smaller shipments, delivery time windows, etc.* (Slabinac, 2015: 1). Big multinational e-commerce companies (Amazon, Google) have significantly invested in research and development of drone technology for last mile deliveries. Various other companies worldwide are currently working on developing technology, drones and resources (people, warehouses) to put drones in use for logistics purposes. Estampe (2015) noted five ways in which drones will be impacting future transport possibilities and logistics in the not-so-far future: (i) save money, (ii) eliminate human error, (iii) keeping humans at home, (iv) delivering goods to places where people would not usually deliver, (v) monitoring and protecting transport lanes.

Heutger (2014) divided the use of drones in logistics into four sub-categories: (i) urban first and last mile, (ii) rural delivery, (iii) surveillance of infrastructure, and (iv) intralogistics. The demand for urban first and last mile will significantly grow due to the e-commerce annual growth rate. Use of drones will secure huge help for cities by taking traffic into air from roads. Drones will provide a huge relief for rural delivery services, since companies will be able to surpass poor infrastructure or challenging geographical settings. Drones will improve the cost side of rural deliveries, as well as quality of delivery services. Use of drones will help in monitoring and surveillance of logistics infrastructure (warehouses, docks, yards,) and in guiding various logistics operations (e.g. moving of forklifts and other vehicles on sites). In the final, fourth sub-category, the use of drones will be of great importance, since drones can support intra-plant transport and emergency transports, which are today performed by helicopters. From the previous four sub-categories, the two most promising are urban first and last mile (improvements in speed and flexibility) and rural deliveries (connecting people in remote locations to worldwide trade networks). Table 4 presents some of the examples where drones are used in logistics for last mile deliveries.

Company	Application			
DHL	DHL Parcel successfully tested its third Parcelcopter			
	generation for deliveries of parcels in Bavaria (Germany)			
	and urgent deliveries of medical supplies to the island of			
	Juist in the North Sea.			
Amazon	Testing Prime Air delivery service with drones. Parcels will			
	weigh up to a maximum of 2.36 kg and should be delivered			
	up to 30 minutes after the order. This delivery option should			
	take over up to 80% of all the deliveries Amazon makes.			
	Successfully conducted a 13-minute drone delivery trial in			
	England – in Cambridge.			
Google	Testing drone deliveries in Virginia, USA. The project is			
	currently on hold, due to the regulation and technical issues.			

 Table 4. Current examples of drone usage worldwide

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7-eleven	Tested drone fast food deliveries in Nevada, USA.
J.D.com	Chinese online store delivered purchased products to their
112 100 m	customers.
Domino's Pizza	In New Zealand, they have started with drone deliveries of
	ordered pizzas.
National postal	Swiss Post tested drone deliveries during 2015;
companies	Finish post tested delivery of parcels in inhabited urban
	environment – from Helsinki to the island of Suomenlinna;
	Croatian post in Mostar has tested drones for parcel
	deliveries in autumn 2016;
	French post started with regular drone deliveries in
	Provence –drones deliver parcels once a week;
	Australia – started testing parcel deliveries within cities due
	to drones' flight range.
Maersk	Tested use of drones for spare parts deliveries, which could
	lead to savings in logistics – the company used drones to
	deliver a box of cookies to a tanker from a nearby seaside
	town.
Mercedes Benz	Presented a complete logistics system for delivery of
	products, which consists of vans with an automated
	warehouse part and drones that will be delivering packages.
	The goal is that all parts of the supply chain are digitally
	connected (from supplier to delivery receiver).

Source: authors' research, 2017

The latest report from Gartner presented a not so bright future for drones in logistics (J. D., 2017). Although Amazon is promoting its drone delivery and has patented their *flying storage*, Gartner predicts that market share for drone delivery by 2020 will not be higher than 1% of total deliveries. Their prognosis is based on complex logistics problems and that return on investments has yet to be proven in this segment. Since all companies look upon costs, earnings and return on investment, this could be the main problem for greater use of drones for logistics purposes worldwide.

# 5. DRONES IN CROATIA - USAGE AND OPPORTUNITIES

Due to the development of technology and current trends in use of drones worldwide, Croatia will also be a place where drones will be used in many different applications. There are already several Croatian companies that are using, and even more that are considering using of drones in their businesses. This will mean that Croatia will be part of global trends, from drone operators and pilot education, to production of drones. Currently, there are more than 130 companies in Croatia which use drones for their businesses. Most companies offer different media and entertainment services, surveillance of land, graveyards, and infrastructure. Until recently, there was only one drone manufacturer in Croatia (Hipersfera), but a few months ago two new companies started drone production (Tarsier drones and Kapetair) (Ivezić, 2017). Current and potential drone use in Croatia was a research subject, and authors (Vlahović, Knežević & Batalić, 2016: 3985) concluded that *implementing delivery drones is in line with business processes perspective*. This offers potential for further automatization of organizations' processes and potential for further improvements in efficiency of organizations' operations, especially in areas of flexibility, service responsiveness, costs and maintenance. The next table presents several examples of current use of drones by some of the biggest companies in Croatia.

Company	Application
Agrokor	Already uses drones in agriculture with which they have some savings in production, and at the same time they have increased productivity. They are preparing for use of drones in other companies and doing pilot training. In their newspaper and parcel distribution company, they see huge potential for drone use in logistics.
Hrvatski telekom	They are evaluating the use of drones in automation of mobile network planning to save on operating costs. Inside the Deutsche Telekom group, drones are already being used for testing signal quality around mobile base stations and for examining mobile base stations. They are also examining drone development and will assess when they will use drones in development of different parts of their business.
Žito grupa	The company is very interested in testing new technologies and potential use of drones in their business. They are evaluating the use of drones for collecting data from planted seeds, for creating digital orthophoto charts, and for analysing the condition of farmland.
Hrvatska elektroprivreda –	The company uses drones for controlling power lines in inaccessible terrain. With drones, they do not need to switch off the electricity while they check for potential malfunctions.
Vipnet	They consider drones as one of elements which, with smart and innovative application can provide huge benefit to their business and are willing to try them as soon as possible.

**Table 5.** Current examples of drone usage in Croatia

Source: adapted from Bačelić, 2016

Most of the current use of drones in Croatia is connected to production or to technology use in telecommunications companies. There is currently only one Croatian company preparing to test drones for logistics purposes – Tisak. They are currently waiting to receive the first delivery of drones for logistics purposes and will start with preparations for first trial deliveries of parcels. The Overseas Trade representative (UPS licensee in Croatia) sees drones as the future and concludes that drone deliveries will suit the users who accept new technologies better and faster the

most. According to them, the future of logistics industry in Croatia and in the world, will be shaped by new technologies as the telecommunications industry was shaped by smartphone development. The Croatian Post is looking at global trends in parcel deliveries, but for them, drones are not such a reliable delivery tools since they depend on weather conditions, have short-range for deliveries and there is an issue with airspace regulation (Logistika.com, 2014).

Dronefest conference, which is being held every year in Zagreb, is also important for future drone use in Croatia. This conference presents the latest information about drones from several aspects of doing business (drone legislation and regulation, different business possibilities, drone types, etc.) and presents an excellent place for the promotion of further use of drones in Croatia. The conference organizer, IN2 company is one of the leaders in introduction of drone usage in Croatia, since they work on development of software for controlling and using drones in agriculture and infrastructure sectors.

Currently, the main barriers for faster and massive introduction of drones in Croatian businesses and logistics are lack of and slow introduction of legal regulation of drone usage.

#### 6. CONCLUSION

Drones are already being used for civil purposes and are expected to increasingly affect our daily lives. The most promising uses of drones are in safety inspections or infrastructure monitoring, in disaster relief or photography, with good potential for transport of goods. The key opportunities for the use of drones are financial and legal support and continuation of rapid development, while the key challenges are the question of safety and privacy issues.

RPAS are controlled by a pilot from a distance and form part of the broader category of Unmanned Aerial Systems (UAS), which also includes aircraft that can be programmed to fly autonomously without the involvement of a pilot. To use their full potential, drones should be part of air transportation, and regulated in an appropriate manner. A key factor in safely integrating UAS in non-segregated airspace will be their ability to act and respond as manned aircraft do. European legal framework must enable progressive development of the commercial drone market while protecting the public interest. Safety and privacy are the most important concerns. Therefore, an appropriate regulatory framework is required. The principal objective of the aviation regulatory framework is to achieve and maintain the highest possible uniform level of safety, thus drones must comply with aviation safety rules. Enlargement of the drone market is hindered because there is no adequate regulatory framework in most Member States. Several Member States have started developing national rules, the Republic of Croatia being one of them, but the absence of European standards will slow down the development of drone market. Development of the complete regulatory framework for UAS will be a long effort, lasting many years.

The main use of drones in logistics is seen for last mile deliveries of parcels, and the main four logistics categories are: urban first and last mile, rural deliveries, surveillance of infrastructure, and intralogistics. Although many companies are testing drones in logistics, the latest reports, which are based on complex logistics problems are not promising. Croatian companies primarily use drones for various media and entertainment services, surveillance of land and crops, and infrastructure. Currently, there are several Croatian companies thinking about testing drones in logistics, but there is still no definite decision for introducing them in delivery operations. The main barrier for faster introduction of drones in logistics in Croatia is lack of and slow introduction of legal regulation of drone usage.

Since the use of drones in logistics is still new in Croatia, we recommend further research in the following directions:

- a) Investigate possible connection between legal regulation and the use of drones in businesses, especially in logistics;
- b) Investigate if the development of drone production industry in Croatia can initiate greater use of drones in Croatian companies in different sectors and not only in logistics;
- c) Investigate possible savings for companies in Croatia by introduction of drones for last mile deliveries instead of traditional logistics vehicles.

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# HUMAN FACTOR AS THE MAIN OPERATIONAL RISK IN DANGEROUS GOODS TRANSPORTATION CHAIN

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#### Abstract

When packaged dangerous goods (DG) are transported by road, it is critical to follow both legal requirements as well as meet suggested safety regulations in order to prevent accidents during activities with chemicals that are harmful for man, assets and environment. Due to the fact that there are multiple parties involved into handling and transportation procedures, plenty of different risks can occur during these activities with DG. As the importance of human factor has been underestimated, this paper focuses on analysing different types of risks within a dangerous goods transportation chain related to specific participant. By analysing and prioritising risks, the most critical of them are identified and evaluated upon possible harm to entire chain. The paper presents a combined overview study based on theoretical aspects and which is supported by results of previous studies regarding risk assessment of DG transport in practice. Additional results of research regarding how involved parties in Estonia evaluate possible harms resulted by their activities while handling and transporting DG confirm the main finding that human factor is one of the crucial factors why accidents occur. Despite the limited study group generalisations of research results are applicable widely in Europe due to the universal features of risks as well as common legal requirements (The European Agreement concerning the International Carriage of Dangerous Goods by Road; i.e. ADR). In scope of further research, results of present study are milestones to focus on managing risks affected by human factor in road transport of DG.

Key words: dangerous goods, road transport, ARD regulations, risks, human factor

#### **1. INTRODUCTION**

All substances that induce severe risk for health, that can harm people, environment and surrounding properties, or other living organisms, are characterized as dangerous goods (DG) (Tomasoni, 2010). Dangerous goods transport (DGT) includes all goods - liquids, gasses, and solids - that include radioactive, flammable, explosive, corrosive, oxidizing, asphyxiating, biohazardous, toxic, pathogenic, or allergenic materials (Berman et al., 2007) and (ADR, 2017). In scope of road transport these are all the substances and materials described in Annex A and B of the ADR, the European Agreement concerning the International Carriage of Dangerous Goods

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by Road (ADR, 2017). Regulations are essential to prevent not only risk, but also to reduce hazard. In the transport of DG the key problem is how to optimize transport and distribution, minimizing the risk of accident (Tomasoni, 2010).

Major activities in logistics include both inbound logistics and outbound logistics, and transportation is one of two critical functional areas besides inventory (Choi *et al.*, 2016). A transportation chain maps the whole route between the place of origin and the destination as well as describes the individual transportation for each route segment along the transport route. A typical transportation chain of DG may include many parties, from consignors and consignees, freight forwarders and carrier companies. From the perspective of present paper, transportation chain starts at consignor's with loading and ends at consignee's with unloading procedure. Considering possible risks in regards with DG, it is vital for transportation chain to operate efficiently and effectively by all the corresponding members function properly. In other words, if any member fails to perform, the system will easily collapse and fail to achieve its objectives (Choi et al., 2016).

DG logistics is a complex system of which the DGT system is a specific subsystem which can be in turn be modelled in several other subsystems (Tomasoni, 2010). The scope of this paper is to survey operational risks within the DGT system based on transportation chain where three different parties are involved – consignor/ consignee, carrier and freight forwarder. When a dangerous event happens, caused by human error, and involving DG, the consequences cannot sometimes be reduced or contained. So, it is essential to apply preventive measure to reduce the probability of occurrence, or/and magnitude of the consequences (Tomasoni, 2010). The aim is to evaluate impacts of risks that are resulted by different operations within the transportation chain during the transport process of DG.

Based on conducted survey research and interviews with different parties of a DG transportation chain in Estonia, a comprehensive operational risk impact assessment framework is developed. Results can be used in further researches to determine proper risk management tools in order to minimize the risks arising from transportation or maximize the level of security in DGT.

#### 2. LITERATURE REVIEW

During the last twenty years, several researches have been carried out by different researchers on the issue of risk assessment on the DGT (Conca et al., 2016). These studies were focused especially on safe transportation using pipelines (Citro & Gagliardi, 2012 via Conca et al., 2016), railway transportation (Liu et al., 2013; Saat et al., 2014 via Conca et al., 2016), and road transports (Fabiano et al., 2002, 2005; Yang et al., 2010 via Conca et al., 2016). The research on road transport of HazMat (Hazardous Materials) follows three topics. The first is related to methodologies aimed at improving emergency response based on road properties, weather conditions and traffic factors (Fabiano et al., 2005). The second is based on methodologies for survey and accident risk analysis from historical data aimed at divulging accident characteristics such as frequency of occurrence, accident consequences, and identification of causal factors (Fabiano et al., 2002; Yang et al., 2010; Shew et al.,

2013 via Conca et al., 2016). The last topic focuses on decision making aimed at improving choice of truck capacity (Guo & Verma, 2010 via Conca et al., 2016) and route (Fabiano et al., 2002 via Conca et al., 2016).

As a fact the improvement of road traffic safety is one of the most important objectives for transport policy makers in contemporary society, and represents a strategic issue for enhance life quality. This is strongly supported by the fact that many studies regarding DGT risk assessment focuses on technical aspects and quantitative methods rather than on risks related to human factor that is studied and analysed by applying qualitative methods to formulate outcomes.

According to the qualitative studies of managing risks in DGT (Krasjukova, 2010) there are three main decision criteria in the sphere of DG road transportation, which can be accepted as sets of preventive means derived out of technical, procedural or personnel factors. Particular risk preventive means related to human factor in road transport of DG that consequently refer to possibly related operational risks are structured as following.

- 1) Risk preventive means concerning procedures within DG transportation chain:
  - a. loading procedures at loading areas according to safety requirements;
  - b. labelling of packaging (clear and easily identifiable labelling of cartons to reduce risk of picking errors);
  - c. loading order and placement of dangerous load in the transport unit;
  - d. restricted parking authorization;
  - e. fixed traffic routes with the necessity to get the confirmation from institutions in control;
  - f. additional road permissions system for third countries;
  - g. higher prices for ferry tickets and tunnel passes;
  - h. daily temporal and seasonal driving bans;
  - i. special procedures when accident occurs;
  - j. compulsory transport documentation and remarks on documents;
  - k. DG shipment tracking system;
  - 1. marking and labelling the shipment and vehicle (Erceg & Trauzettel, 2016; Krasjukova, 2010).
- 2) Risk preventive means concerning personnel and parties involved:
  - a. ADR training for drivers;
  - b. ADR training for safety advisers (freight forwarders and logisticians);
  - c. work safety and ergonomics trainings for personnel;
  - d. economic driving training for drivers;
  - e. performance appraisals with personnel (Krasjukova, 2010).

In relation to the main topic of this paper specific human related risk preventive means are defined above. Preventive means, pointed out, are currently widely in use in road transport sector and have become as binding requirements and compulsory procedures in the overall process of DGT.

Transport is always associated with human risk factors that cannot be completely excluded. This paper deals with human related risk preventive means in details by the evaluation of possible harms resulted by activities while handling and transporting DG within the transportation chain. In following parts, the semi-quantitative method

to evaluate impacts of operations within the DG transportation chain is applied and results are presented. Despite the limited study group adequate data is collected and operational risk assessment is performed on example of DG transportation chain parties of Estonia.

## **3. BACKGROUND**

#### 3.1. ADR regulations

In ADR appear the limitations applicable to the various operators of the logistics chain (buyers, transporters, manufacturers of packaging and tankers *etc.*) giving specific treatment to their field of activity. The regulation topics of law ADR are as following:

- 1) the method of identification of DG;
- 2) the lists of DG permitted for transport on the roads;
- 3) the modality regarding transport, type of packaging and the connected approval tests;
- 4) the planning and construction of the tankers;
- 5) the checks and the recognition of technical suitability of the vehicles used to transport the DG;
- 6) the training and recognition of the vehicle drivers (Tomasoni, 2010).

Laws and regulations on the use, loading, unloading, storing, transporting, and handling of DG may differ depending on the activity, status of the material, and modality of transport used. Most countries regulate some aspect of DG at UNECE (The United Nations Economic Commission for Europe) level (UNECE, 2010), that is the most widely applied regulatory scheme. The UN Recommendations on the Transport of Dangerous Goods form the basis of several international agreements, such as UNECE regulations and many national laws (UN Recommendations on the Transport of Dangerous Goods, 2015).

The transport of DG is an activity which is increasingly international and multi methodological. Regulations involved can therefore not disregard connect itself to international level to sustain a future integrated logistics system with multi method efficiency (Tomasoni, 2010).

#### 3.2. Responsibilities of parties involved into DGT

With regards to transportation of DG on roads there are traditionally same parties involved as when transporting general goods. The main difference is noted related to responsibilities of participants in the carriage of DG and obligations on those that ADR considers the main participants. According to ADR there are main parties (consignors; carriers; consignees) and so-called other parties (loaders of packages; packers; fillers; tank-container/ portable tank operators; unloaders of packages or of tanks/ bulk vehicles) mentioned.

There are even more participants involved in the safe transport of DG that are not mentioned in ADR Chapter 1.4 on safety obligations of the participants. From the

perspective of transportation chain of DG the foremost amongst these are drivers, who are not mentioned but whose safe driving is perhaps one of the most critical factor for ensuring the safety of the general public during the transportation of DG. The driver is usually responsible for checking that they have the right fire extinguishers, in the correct condition, as well as the other emergency and personal protective kit prescribed in ADR. The driver is also usually considered responsible for ensuring the correct paperwork for themselves, their load and, if applicable, the vehicle is present and in order (Waight, 2015).

Another party whose safety obligations are not mentioned in ADR are freight forwarders. A freight forwarders might not come into direct contact with the goods, even though they will be passing on the documents and instructions to those who are. The role of freight forwarder is vital in transmitting critical information within the transportation chain and should not be underestimated. Other parties that may also be important but that are not directly included into transportation chain of DG are the following:

- 1) those who manufacture, test and certify packages, tanks and bulk vehicles;
- 2) those who test DG for their properties;
- 3) those who provide a classification of the goods;
- 4) cleaners and decontamination workers;
- 5) manufacturers and distributors that use other parties (such as freight forwarders) to consign on their behalf (Waight, 2015).

The UN Recommendations on the Transport of Dangerous Goods — Model Regulations outlines the steps that need to be taken to ensure the safe carriage of DG (UN Recommendations on the Transport of Dangerous Goods, 2015). Most of the international or major regional requirements that reflect the UN's provisions, generally do not detail the responsibilities of those involved (Tomasoni, 2010). ADR Chapter 1.4 cites the arrangements concerning safety which must be taken into account by every person involved in the transport of DG. In this chapter the carriers and all others involved in the transport of DG at high risk are required to adopt, carry out and follow a safety plan. This must include:

- 1) specific roles of responsibility in the matter of safety;
- 2) the recording of the DG in question and their typology;
- 3) the monitoring of the vehicles;
- 4) definition of the measures to adopt to reduce the safety risks;
- 5) efficient procedures to identify and face threats, safety violations and incidents connected to safety;
- 6) procedure of evaluation and verification of the safety plans;
- 7) measures to assure the physical protection of information connected to the transport contained in the safety plan;
- 8) measures to assure that the distribution of information connected to the transport operation, contained in the safety plan, is limited according to necessity (Tomasoni, 2010; ADR, 2017).

#### 3.3. Risks

On a national scale it is shown that DGT accidents on the roads make up no more than 0.1% of total accidents (Eurostat, 2016). But, even though this probability is minimal, the consequences are important when dangerous substances are involved. Regulations are essential to prevent not only risk, but also to reduce hazard. Firstly, the risk attached to the transport of DG by road is a risk that is hard to understand as it is connected to all the road network and depends on multiple factors such as traffic density, weather conditions, the necessities of undesired events (road accidents, natural phenomenon *etc.*). Secondly, this risk is also strongly linked to the nature of the transported goods and to the presence of exposed humans and materials in proximity to the place of incident. For example, the transport of fuel such as petrol or GPL (*a.k.a.* liquefied petroleum gas, liquid propane gas, LPG, LP Gas) can provoke considerable fire or the explosion of the tankers in which it is transported, with heat, excess pressure and missile effects (Tomasoni, 2010). Thirdly, the risk of DGT is strongly related to a human factor as all decisions, processes and procedures within a transportation chain are made by different parties involved.

According to classical definition of a risk it is a measure of frequency and severity of harm due to a hazard. The hazard in this context is the presence of DG having toxic, explosive, and/ or flammable characteristics with the potential to cause harm to humans (and property or the environment if a broader context is considered). In the context of public safety, risk is commonly characterized by fatalities (and injury) to members of the public (Risk Assessment – Recommended Practices for Municipalities and Industry, 2010).

Risk arising by DGT represents a particular threat which needs strategies and tools to reduce risk rate of society, property and environment (Conca *et al*, 2016). Several factors contribute to making it difficult to assess risk in transporting DG, including:

- the diversity of hazards in addition to main danger characteristic: the substances transported are multiple and can be flammable, toxic, explosive, corrosive or radioactive materials at the same time;
- the diversity of accident sites: highways, county roads, local roads, in or out of town (75% of road accidents take place in open country), facilities, pipelines, *etc.*;
- 3) the diversity of causes: failure mode of transport, containment, human error, *etc.* (Tomasoni, 2010).

## 4. PROBLEM DESCRIPTION

DGT is a worldwide problem of growing interest, mainly because of the increasing transported volumes of materials that can be classified as DG, and because of a global challenge in the goods transportation performance (Tomasoni, 2010). Based on statistics the transport of DG in the EU-28 slightly increased from 74 billion tkm in 2013 to 75 billion tkm in 2014 (+1.5%). The largest specific product group was flammable liquids, taking over more than half of the total. Two other groups, gases

(compressed, liquefied or dissolved under pressure) and corrosives, accounted for 14% and 10% respectively. This represents very little change compared with previous years showing a very similar distribution between product groups (Eurostat, 2016).

When the transport network crosses heavily populated areas, a large number of persons could be affected by an accident such as a toxic spill or an explosion (Leonelli *et al.*, 1999). There is a substantial difference between incident and accident. The accident begins with an incident (Crowl *et al.*, 2007). An incident is defined as an event involving the transportation of DG that results in an unanticipated cost to the shipper, carrier or any other party (Tomasoni, 2010). In scope of this paper incident is considered as an operation or a procedure involved into the transportation chain of DG. It has been reported that human error is in fact the most common individual cause of DG related accidents. According to European Community's data on road transportation of DG it was found that almost half of the accidents are caused by a human error, or at least error due to human factor was a major contributor for the accident, whereas at the same time only some 8% of accidents were caused by a technical failure (Eurostat, 2016).

Risks facing different parties and their operations within the transportation chain of DG can result from factors both external (culture, regulations, board composition) and internal (accounting controls, information system, requirement, supply chain) the organisation (A Risk Management Standard, 2012). Operational risks in logistics as well as in DGT have both external and internal key divers. Operational risk can be summarized as human risk; it is the risk of business operations failing due to human error. Industries with lower human interaction are likely to have lower operational risk (Investopedia). In the DGT, most operations are run in contribution of a personnel involved, apparently operational risks are higher. Despite the fact that the probability of operational risk emerging in DGT is minimal, consequences can be crucial. The problem lies in the fact that the importance of human factor has been clearly underestimated - it is unknown what are exact operational risks within the transportation chain of DG and how severe they are. For effective DG risk management it is important to pay attention to operational risks within complete transportation chain of DG from the perspective of all parties - consignor/ consignee; freight forwarder; carrier. The aim of present paper is to commit detailed analysis of operational risks of different parties that allows to understand clearly the contrasts of risks of participants as well as assess them.

#### 5. METHODOLOGY

To assess the risk, then analyse and estimate the level of risk of accidents three different methods: qualitative, semi-quantitative and quantitative are defined (Dziubinski *et al.*, 2006). Qualitative methods are used mainly in the validation of safety standards with regard to legal rules on the transport behaviour. These rules are usually considered as a minimum requirement that must be used to achieve certain levels of acceptable safety. The semi-quantitative methods are applied to identify hazards and to select the so-called incidental events reasonably foreseeable (credible failure events). The quantitative assessment of risk is complex and involves a series

of analysis and calculations, using many simulation models, particularly the physical analysis of the effects (Tomasoni, 2010).

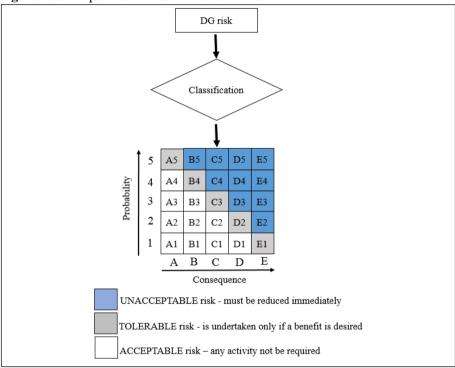
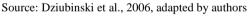


Figure 1. Semi-quantitative DG risk assessment



Considering the specifics of operational risks in DGT, semi-quantitative risk assessment methodological approach, as shown above (Figure 1) can be adjusted in order to identify incidents leading to accidents (*i.e.* risks) and to estimate the level of risk. Based on this methodology risk probability is scaled in range of 1-5 (1 - rare; 2 – unlikely; 3 – likely; 4 – certain; 5 – imminent) and severity of risk that may arise from the possible event or outcome is scaled in range of A-E (A – minor; B – medium; C – major; D – catastrophic; E – catastrophic external) (Dangerous Goods Safety Guidance Note, 2013).

In the risk assessment definition, many concepts are involved. Risk is most commonly defined as the combination of the probability (frequency; likelihood) of occurrence of a defined hazard and the magnitude of the consequences of the occurrence as it is described by formula (1) below (Royal Society, 1992).

$$DG Risk = Consequence * Probability$$
 (1)

At this point it is important to emphasize that hazard and risk are not the same. Risk is a function of hazard, as hazard is related to the intrinsic characteristic of a material, good, condition, or activity that has the potential to cause harm to people, property, or the environment, and it is often defined in terms of a probability (EEA, 1998). Danger is defined as all processes involved in the chain or sequence of events leading to an undesirable event which could have a destructive nature on population, ecosystems and goods. Probability is defined as a value between 0 and 1 and in some words is the likelihood of a sequence of events to an event not desired (Tixier *et al.*, 2010).

In the risk evaluation it is essential to say that the zero risk does not exist. In DGT the zero risk is excluded as long as the DG moves along the transportation chain from starting point to point of destination. In the process of DGT there is always a level of acceptability, even if the perception of hazard, danger, and also of risk is not so easy to quantify (Tomasoni, 2010). The risk assessment may include an evaluation of what the risks mean in practice to those affected. This will depend heavily on how the risk is perceived. Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem (EEA, 1998).

This paper focuses on evaluating operational risks of different parties within the transportation chain. In order to map risks within a transportation chain of DG, risks were evaluated among different parties in Estonia affected to identify what they mean to them. Data collection was performed during a comprehensive survey research with the focus to evaluate frequency (probability) and possible harms resulted (consequences) by their activities while handling and transporting DG. The survey covered companies related to DGT by road – consignors and consignees, freight forwarders and carrier companies. Due to the fact that the majority of carrier and freight forwarding companies in today's market situation have somehow been related to the transportation of DG - all of these companies turned out to be in the selection. Consignor and consignee companies as a single party were selected according to their primary activity. Most of them represent companies that produce different chemicals, building materials or use hazardous materials on a daily basis in their activity. By implementing semi-quantitative risk assessment method, it finally allows to differentiate operational risks according to their levels into acceptable, tolerable and unacceptable operational risks when transporting DG on roads as on figure upon (Figure 1).

#### 6. RESULTS

This chapter describes results of DG risk assessment based on conducted survey research and detailed interviews among different parties of a DG transportation chain in Estonia. Based on ADR Chapter 1.4 on safety obligations of the participants of transportation chain of DG and according to ADR Chapter 1.10, which cites the arrangements concerning safety which must be taken into account by every person involved in the transport of DG operational risks of all parties are defined. As a first

step of risk assessment, operational risks of different parties were defined on a basis of Estonian companies that represent different roles within the DG transportation chain.

The data collecting on operational risks within the transportation chain was performed in forms of non-anonymous online survey (carrier companies, freight forwarders) and structured interviews (consignors/ consignees). To ensure the representativeness, the sub-samplings were formatted in a non-probability sampling technique where the samples are gathered in a process that does not give all individuals in the population equal chances of being selected (Babbie, 2010). Within this study samplings are also qualified as purposive samplings where subjects are chosen to be part of the sample with a specific purpose in mind that sufficient to draw objective conclusions concerning methodological approach of some subjects are more fit for the research compared to other individuals (Ibid.). The distribution of the online questionnaire was provided via email invitations (136 companies that work with DG on a daily basis). Altogether 74 replies were gathered: 17 responses from freight forwarders; 57 responses from carrier companies. Some main descriptive statistics for research sample of carrier and freight forwarder companies and their shares of total sample is presented below in Table 1 and Table 2. According to these tables the majority of carriers within a sample represent companies with a considerable experience in DG transport. The experience of freight forwarder companies is considerably even. Based on volume of handled DG per year 11 most important consignors/ consignees were selected for interviews. The total products capacity of these companies form up to 80% of all dangerous goods substances handled by consignors/ consignees' companies of Estonia.

Experience in DG	. 1	1.0	2.5	5 10	. 10
road transport in years	<1	1-2	2-5	5-10	> 10
Carrier	2 (4%)	0 (0%)	5 (9%)	11 (19%)	39 (68%)
Freight forwarder	2 (12%)	5 (29%)	2 (12%)	3 (18%)	5 (29%)
ource: Authors T <b>able 2.</b> Average numb		ipments			
	per of DG sh	ipments	3-5	6-10	> 10
able 2. Average numb	ber of DG shi DG th	1-2			> 10 30 (53%)

Table 1	Working	experience	in DG	transportation
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Source: Authors

According to questionnaire responses and additional detailed interviews, main activities that involve risks while handling and transporting DG from the perspective of consignors/ consignees, freight forwarders and carriers are presented below in Table 3. The table is supplemented with some descriptive statistics that indicates on how highly was peculiar operational risk evaluated as an operational risk that is influenced by human factor from the perspective of specific party itself within a DG transportation chain. Parties named operational risks independently and evaluated them on a scale from 1 to 5 points. Hence, 1 point was for the smallest influence and 5 points for the greatest influence of a human factor by specific operational risk. Taking into account the fact that there were different number of companies involved info sub-samplings, the highest possible score for evaluating operational risks differ hereby. It is also important to note that many operational risks have a repetitive nature in case of activities of different parties (*e.g.* improper/ incomplete transport documentation; inaccurate customer communication).

<b>Consignor/Consignee</b>	Freight forwarder	Carrier company
(11 companies; max score	(17 companies; max	(57 companies; max
55 of points)	score of 85 points)	score of 285 points)
Improper transport	Incomplete transport	Incomplete transport
documentation (51p)	documentation (37p)	documentation (140p)
Incomplete transport	Inaccurate customer	Missing transport
documentation (44p)	communication (46p)	permits and licenses
		(108p)
Inaccurate customer	Wrong route planning	Not safe load securing
communication (29p)	(26p)	(105p)
Wrong classification of		Inadequate load
DG (21p)		securing (89p)
Improper packing material		The use of incorrect
(22p)		load restraints (86p)
Inadequate packaging		Wrong / missing
(31p)		vehicle placards (89p)
Missing marks and labels		Inaccurate customer
on the package (21p)		communication (137p)
Wrong marks and labels		Wrong route planning
on the package (19p)		choice (85p)
Insecure loading/		Driver's caused error
unloading (25p)		accident (80p)

Source: Authors

By defining operational risks within the DG transportation chain makes it possible to evaluate both consequence and probability of these risks. According to structured questions in the questionnaire, respondents evaluated these indicators in the range of A-E (consequence) and 1-5 (probability). Following table (Table 4) presents an overall rating to DG operational risks from the perspective of different parties. Rating represents a combination of letter and number – the letter stands for risk consequence value and the number describes its probability. According to rating, each

risks can be positioned in a DG operational risk matrix for final specification as acceptable, tolerable or unacceptable risk.

DG operational risk	Consignor/ consignee	Freight forwarder	Carrier
Inaccurate customer communication	B4	C3	D2
Incomplete transport documentation	C4	C2	D2
Improper transport documentation	D3	C2	D2
Missing transport permits and licenses	B2	C2	D1
Not safe load securing	C2	C2	D2
Inadequate packaging	D2	C1	D2
Insecure loading/ unloading	B1	C1	D2
Wrong classification of DG	B1	C2	D1
Inadequate load securing	B3	C1	D1
The use of incorrect load restraints	B3	C1	D1
Driver's caused error / accident	B3	C1	D1
Improper packing material Wrong / missing marks and labels on	B2	C2	D1
the package	B1	C2	D1
Wrong route planning /choice	B1	C2	D1
Wrong / missing vehicle placards	B1	C1	D1

<b>Table 4.</b> Railings of DO operational fisks	Table 4.	Ratings	of DG operatio	nal risks
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Source: Authors

By implementing semi-quantitative DG risk assessment methodology operational risks are differentiated according to their levels into acceptable, tolerable and unacceptable. Detailed results of participants' operational risk matrixes are presented below (Figure 2).

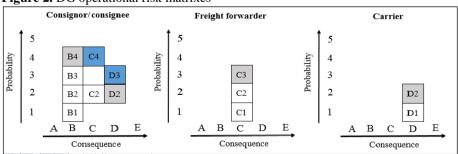


Figure 2. DG operational risk matrixes

Source: Authors

Figure 2 shows existing operational risk matrixes of consignor/ consignee; freight forwarder and carrier separately in combination of consequence of an incident and its probability within the DG transportation chain. The results underline how differently operational risks influence participants' activity within DG transportation chain. The empirical result indicates consignor's/ consignee's and carrier's risks as most severe when handling and transporting DG by roads. Based on results of risk assessment, unacceptable risks are related to incomplete or improper transportation documents and exist clearly outstanding only from the perspective of consignor/ consignee, *i.e.* in the beginning or at the end of the transportation chain. Inaccurate customer communication is a great concern for all parties and is defined as tolerable risk. This may indicate on deficiency of information flow. Even the smallest loss of information between the parties of DG transportation chain may lead to additional costs. Hence, freight forwarder's risks do not need any additional activity and the activity of this party can be considered as the most risk free within the DG transportation chain. Mainly half of carriers' operational risks are classified as tolerable risks with major consequences and with a slight possibility to take place. Identifying operational risks of different parties in Estonia within the DG transportation chain increases the awareness of role of human factor when handling and transporting DG.

## 7. CONCLUSION

Risk management is one of the key issues during planning safe handling and transportation of DG. Examining risks by means of semi-quantitative risk assessment method it allows to focus strictly on operational risks that are resulted by activities of different parties within DG transportation chain. There are plenty of activities when handling and transporting DG that are considered as incidents but do not necessarily lead to accidents. In order to identify which of human factor activities are closer to emergence of the accident in practice it is necessary to:

- 1) examine the transportation chain of DG as a complex of loading, transportation, freight forwarding and unloading procedures;
- 2) identify operational risks from the perspective of main parties involved;
- 3) assess risks in the combination of risk consequence and its probability.

The human factor has a considerable impact on ensuring safety in DGT. The number of DG operational risks of different parties and detailed operational risks assessment confirm that human factor is one of the crucial factors why incidents turn into accidents. Accidents within the DG transportation chain are caused mainly due to the number of parties involved, repetitive nature of operational risks at parties involved and the possible consequence of an event. Probability is a secondary aspect when assessing DG operational risks. Results of the study highlight, in particular, the important role of consignor/ consignee as the number of different operational risks is the largest and their levels the highest. In the scope of further studies, the exact knowledge of operational risks in practice creates opportunities to manage these risks individually (from the perspective of each party separately) within the DG transportation chain. The focus of further studies is to find possibilities how to manage

operational risks within the DG transportation chain by providing methodologically effective ADR regulations training courses.

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# II. PRODUCTION LOGISTICS

# ANALYSING THE VALUE OF INFORMATION FLOW BY USING THE VALUE ADDED HEAT MAP

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#### Abstract

Inadequate internal communication and insufficient information transfer is already recognized as a non-value-adding waste. To achieve a higher value creation, an identification and categorization of information transfer is necessary. Common methods are unsuitable especially for visualizing information media disruptions and lead to errors in the added value. Moreover, media disruptions mostly cause redundancy and additional effort, which are reflected in non-value added activities. The Value Added Heat Map is a visualization tool that categorizes and visualize the information flow different from other visualization tools e.g. the value stream analysis. The first step in categorizing the information flow using the Value Added Heat Map is the value analysis of the information transmission. In a second step, the information flow is visualized in the factory layout depending on the value. The innovative method Value Added Heat Map is described and exemplarily applied to an information flow of a production shop floor. The results show that the Value Added Heat Map method can contribute to a better transparency of the often not fully documented internal information flows. This innovative approach enables the visualization of media disruptions via colour transitions and thus helps value added processes by identifying and eliminating possible sources of waste.

**Key words:** Value Added Heat Map, Value of an Information, Value Added Concentration, Information Flow, Digitalization, Digitalization Degree, Media disruptions

# **1. INTRODUCTION**

An information flow uses data and documents to describe the communication between production and controlling processes (Erlach, 2010, p. 32-33 as well as Koch, 2015, p. 138). In literature, there are data visualization methods in application to big data (Gorodov & Gubarev, 2013, p. 3-7), but there are only a few approaches for visualizing information flows for intralogistics processes (Günthner & Schneider, 2011, p. 32). Know visualizing tools, e. g. Value Stream Analysis or Sankey-Diagram,

focus on the material flow than on the information flow. Moreover to date there exists no adequate methods, including the Value Stream Analysis or Sankey-Diagram that classifies the value of an information flow.

# 1.1. Scientific Aim of Analysing the Value of Information Flow by Using the Value Added Heat Map

Inadequate internal communication or defective information transfer is already recognized as waste (Schröder & Tomanek, 2012, p. 17). Notwithstanding the importance of information in the era of digitalization, the visualization of information flow in production shop floor has still a marginal meaning. The aim of this paper is to point out the value of information flow and media disruptions. For this reason the authors developed an innovative evaluation scale to classify information flow following the added value. There is no comparable method existing for evaluation of information to date. This value added scale has been verified by the authors in the shop floor of a production. The collected data was visualized by using the Value Added Heat Map by Schröder and Tomanek, which has been for the first time adapted to the analysis of the value of information.

## 1.2. Value Stream Analysis

Value Stream Analysis is a proven method for identifying and avoiding wastage within a production process. Originally developed in the 1990's and linked with the Toyota Production System, Value Stream Analysis is used today in many industries for process improvement. In the Value Stream Analysis arrows are generally used as a symbol for the information flow (Table 1). A jagged arrow symbolizes electronic information, e.g. a master over the ERP system. A straight arrow represents a manual information transfer. This may, for example, be the master giving the worker previously received oral instructions from the company software. Transmission of information, in particular in the production sector can also be mapped through a go-and-see planning, a levelled production planning or a Kanban symbol (Balsliemke, 2015, p. 9 as well as Rother & Shook, 2000, p. 100-101).

Symbols for the information flow	Meaning
<b>←</b>	manual information flow
- <b>-</b> -	electronic information flow
6-0	electronic information flow
OXOX	levelled production planning
r	Route of a kanban card

**Table 1.** Value Stream Analysis - symbols for the visualization of an information flow

Source: Balsliemke, 2015, p. 9 as well as Rother & Shook, 2000, p. 100-101

#### 1.3. Sankey-Diagram

The Sankey-Diagram had originally only been used for thermodynamic systems. Heat losses could be easily identified with this tool. Step by step this method has been successfully applied to other disciplines (Sankey, 1896, p. 182–212 as well as Schmidt, 2008, p. 82-94). Today the Sankey-Diagram is a well-known analyzing tool is used to. Applied to a shop floor it can be used to visualize the flows of materials or costs and identify material losses, for instance by production faults or inefficient processes. The main component of a Sankey-Diagram are arrows. They interlink the individual process steps and the direction of the flow. The thickness of the visualized arrows represents the quantity of the substance, which occurs in the flow (Sankey, 1896, p. 182–212 as well as Schmidt, 2008, p. 82-94).

The visualization of a Sankey-Diagram can be combined with a layout of a shop floor. The drafting of this diagram starts always with recording the flows of the occurring substance within the analyzed subsystem. The result is a simple, model-like diagram of the analyzed process steps and material flows, which allows a practical assessment of the regarded system. Within a shop floor the Sankey-Diagram can e.g. display crossing material flows, which cause production backlogs. Transport bottlenecks or material loops are further examples that can be visualized by this method. Consequently, waiting times in the production could be explained.

#### 1.4. Value of an Information

The transmission of electronic information in an oral form constitutes a media break. A media break is a change of medium during the transmission of information within the transmission chain (Gabler Wirtschaftslexikon, 2015, online). If received information is further developed into another form, then this development may create communication problems. Mistakes in the transmission of information can lead to errors in the added value. Moreover, media disruptions cause redundancy and additional effort, which are reflected in non-value added activities such as printing, copying and scanning. From an added-value perspective, media disruptions should be minimized, or, better still, eliminated.

Identifying media disruptions is sometimes very difficult in practice. The problem lies both in the lack of transparency in the information flow within the company and in the absence of adequate forms of design. In the literature, for example, no independent symbol exists for the visualization of media disruptions.

#### **1.5. Value Added Concentration**

Operational activities that are not creating value are equal to wastage that should be minimalized or eliminated. Wastage is defined as a creation effort that a customer is not willing to pay for (Bergmann & Lacker, 2009, p. 161 as well as Bhasin & Burcher, 2006, p. 56 - 72). An approach to assess the added value is the analysis of the Value Added Concentration. The Value Added Concentration negatively correlates to wastage. The less wastage occurs within a process the higher is the Value Added Concentration. The same applies vice versa. Three key factors covers the assessing of the Value Added Concentration: personnel deployment, resource usage and space usage (Schröder & Tomanek, 2012, p. 21). A maximum utilization of the personnel, which is directly participating in the value creation, is expedient because they perform the creation of products or services. In order to concentrate the value added, the value added staff members should focus their working capacity and on their core tasks. Optimization of the resource usage, e.g. equipment or machines, should also be pursued to ensure the maximum concentration of benefit. Spaces within the shop floor are usually a highly limited good. Unused or reserved space create no or only limited value. The primary aim should be to reduce spaces that do not create value, to ensure that sufficient space for the actual value adding process is available (see Fig. 1).

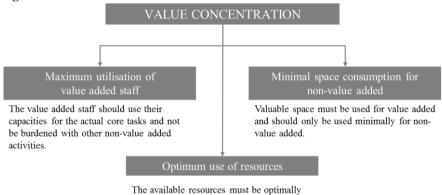


Figure 1. Value Added Concentration

The available resources must be optimally used for value added.

Source: own research

An innovating method for the analysis of the Value Added Concentration in a shop floor is the Value Added Heat Map by Schröder and Tomanek.

#### 2. METHOD DESCRIPTION - VALUE ADDED HEAT MAP

The Value Added Heat Map by Schröder and Tomanek is an innovative visualization tool that indicates the level value creation concerning production relevant factors. It is following the methodically of a thermal heat map camera.

This method is e. g. already used to visualize the usage of production space with regard to their value. Spaces in a shop floor have different values. For example, spaces are maximum, limited and no value added.

Spaces that are directly used for value creation, e.g. production machines, are maximum valuable. But in production, you can also find spaces that are not directly used for value creation. These spaces are necessary for operating the plant - e g. staging areas for required materials, spaces for intermediates and finished goods or transport routes for reaching the plants. These spaces have limited added value contribution. Spaces do not contribute to value creation, when they are not used at all.

In a Value Added Heat Map, each square meter of an analysed shop floor is evaluated with regard to a value level (Tomanek & Schröder, 2016, p. 315-323). The Value Added Heat Map supports the optimizing of a production layout. It aims to generate smaller area with the same value.

In general the Value Added Heat Map helps to visualize the value added level of production relevant factors by using colour scaling and develops a conclusive key performance indicator. The graphical result of the analysis resembles a thermal image; therefore, it is called Value Added Heat Map. Potentials for improvement can easily be recognized by using this method. The Value Added Heat Map is not limited to improve the usage of available space. It can be applied to further production relevant factors like internal traffic (Tomanek & Schröder, 2017) or information flow.

#### 2.2. Value Added Heat Map - Evaluation Scale for Information Flow

Concerning the information flow, it is important to note that information contribute differently to the added value. As shown in Table 2, the information flow is classified by the authors in six value added levels from zero to five. As a scale for the categorisation serves the effort that is need for the information exchange. The higher the effort, the lower the value added level and vice versa.

Insufficient, incorrect or unnecessary exchange of information cause effort by failures. This not value added and has the level "0". The colour dark blue represents this category.

Written exchange of information (e.g. paper document, fax, e-mail, etc.) is limited added value, but it has still a high potential for improving. The time needed for writing consumes human resources. It is classified with the level "1".

Verbal or visual exchange of information is classified with the value added level of "2" because it's less time-consuming than writing. Nevertheless speeches or visuals cues can be often get misunderstood that leads to a low added value.

A higher categorisation has an electronic exchange of information. In the case of electronic exchange, it makes sense to differentiate between an information flow in real-time and not real-time. A spreadsheet application for example is a time-delayed presentation of the data. Furthermore the data maintenance of a spreadsheet is time-consuming than a system application. This is why an electronic information flow not in real-time has the value added level of "3" and in real-time the level "4".

The highest value added level for information flow is represented by digitalisation. Implementing Internet of Things and Services in a shop floor workers and machines communicates in a network in real-time. The digital exchange of information is maximum added value and has the level "5".

		Mup Evaluation Seale for Information 110	-	
Categorization	Value Added Level	Dimension of Information Flow	5	Scale
No Added Value	0	Insufficient, incorrect or unnecessary exchange of information	2	
	1	Written exchange of information (e.g. paper document, fax, e-mail, etc.)		
Limited	2	Verbal or visual exchange of information		
Added Value	3	Electronical exchange of information not real-time (e.g. by spreadsheet application)		Effort
	4	Electronical exchange of information real- time (e.g. by system-application)		
Maximum Added Value	5	Digital exchange of information real-time (e.g. by Internet of Things and Services)		

Table 2. Value Added Heat Map - Evaluation Scale for Information Flow

Source: own research

# **3. SURVEY DESCRIPTION**

A current layout of the analysed shop floor is required to draft a Value Added Heat Map. The layout serves as the basis for the assessment of the information flow. The information flow is represented by arrows. In a Value Added Heat Map, the arrow's thickness represents the quantity of the substance, which occurs in the flow. In the case of analysing the information flow, the thickness refers to the amount of information units.

To identify the information exchange of a process it is helpful to visualize and quantify the material flow first. It is important to investigate, which information enhance the material flow. It is also relevant to record the number of information units, which generated and transferred by the process. It is advisable to adjust the dimension of the information flow to a time unit. The authors recommend a shift or a day as a suitable time unit.

Each information transfer has to be determined according to the evaluation scale for information flow (Table 2). The pursued information flow corresponds to a digital exchange of information in real-time without media disruptions.

Consequently the value added level of the information exchange determinates a digitalisation degree. The Value Added Heat Map for the production relevant factor information flow is supplemented by the key performance indicator "layout-specific digitalisation degree". The layout-specific digitalisation degree is calculated from the quotient of the sum of each information transfer multiplied with the corresponding value added level and the amount of transferred information per time unit multiplied

with the highest possible value added level (see Equation 1). Following the evaluation scale for information flow in Table 2, the highest possible value added level is "5". The layout-specific digitalisation degree indicates, which percentage the degree of information flow promotes added value.

Equation 1. Key Performance Indicator "(Layout-specific) Digitalisation Degree"

(Layout - specific) DIGITALISATION DEGREE =  $= \frac{\sum_{i=1}^{N} (Information Transfer \times Value Added Level)_{i}}{N \times Max(Value Added Level)} x 100;$ Information Transfer i = 1, ..., N; N = Amount of transferred information per time unitValue Added Level = 0, ..., 5;

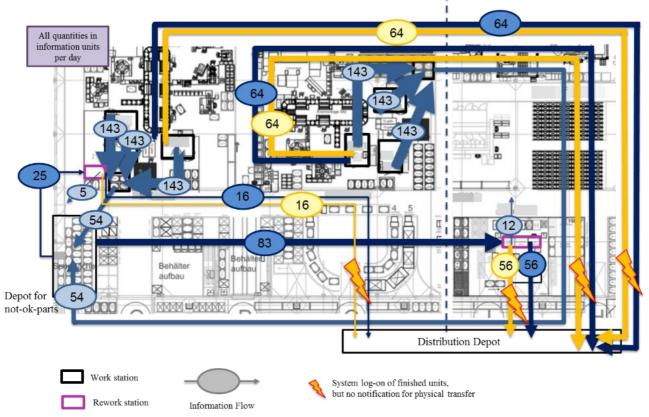
Source: own research

#### 4. RESULTS

The authors applied the Value Added Heat Map method at a production facility of an automotive supplier. The information flow of a production process including the rework are analysed with said method. The analysed production line area contains six working stations. From these working stations ok-parts are transported directly to the distribution depot and not-ok-parts have to be reworked in two rework stations. For the reason of a high rework effort, not-ok-parts has to be temporary stored in a depot. The resulting Value Added Heat Map for Information Flow is shown in Fig. 2. It displays the colour scaling and the relative to value added levels. The layout-based digitalisation degree of the shown example is 21%.

Analysing the value of information flow by using the value added heat map Dagmar Piotr Tomanek, Jürgen Schröder

Figure 2. Example of a Value Added Heat Map for a Production Line Analysing the Information Flow



Source: own research

Based on data from a multi-moment-recording, an information flow of 1.491 information units per day was identified. A total of 308 information units per day were no added value. They were classified with the value added level "0". This corresponds to 20% of the recorded information flow. This group contains missing notification for physical transport of goods. Based on observations, the forklift operators were searching for the boxes with ok-parts and not-ok-parts. This insufficient exchange of information caused non-value-adding wastage: unnecessary searches and handling for the forklift operators, stock keeping in the production line, and empty journeys of the forklift. In Figure 2, the non-value-adding information flow is coloured in dark blue.

A total of 983 information units per day were written notification that were classified with the value added level "1". This corresponds to 66% of the registered information flow. In Figure 2 written exchange of information has the colour light blue.

Verbal or visual exchange of information corresponding to the value added level "2" was not identified in the analysed production line.

A non-real-time electronical exchange of information was found 200 times a day. This matches to 13% of the registered information flow. In Figure 2 this information flow is represented in by yellow arrows that corresponds to the value added level "3".

Both electronical and digital exchanges of information in real-time, which are classified with the value added levels "4" and "5", were not identified.

#### 5. CONCLUSION

The value stream method visualizes in an outstanding way the material flow. By contrast the potentials of the description of the information flow is not visible at first appearance. Stock, latency or lay time get negative influenced by missing, sluggish and incomplete information flow and consequently they extend generally the cycle time. The presented method of the Value Added Heat Map analysing the information flow shows a possibility, how losses of time can be visualized through deficient or defective information. Key recommendations from this work are: optimize the information flow, benchmark the information flow and transfer the Value Added Heat Map to other production relevant factors.

#### 5.1. Optimize the Information Flow

The information flow promotes added value. A layout-based digitalisation degree of 21% in the shown example points out potential for improvement regarding the value added degree. In the first step the information flow with the value added level "0" has to be eliminated immediately. In the shown example the notification for the transport of ok-parts and not-ok-parts must be available to the forklift operator. A technical possibility is that the already existing electronic system log-on of finished goods request a physical transfer of good directly by the forklift operator.

In a second step the information flow with the value added level "1" has to be minimized. A to 66 percent paper-based production line in Figure 2 disclosure savings potentials. Through digitalisation 983 written documents per day can be saved. This reflects not only in saved costs, but also in time saved by reducing the writing effort. In general the intension of an improvement of the information flow through digitalisation is an improvement of the value creation. This includes also the minimisation of media disruptions. Multiple media disruptions in Figure 2 are visualised by colour shifts of the information flow.

Summarizing the application of the Value Added Heat Map can be used to optimize the information flow by pointing out a missing information exchange, determining the digitalisation degree and visualizing media disruptions.

#### 5.2. Benchmark the Information Flow

The Value Added Heat Map method can be used to visualize and benchmark the information flow of different single production lines or even different production plants of one company. An industry-wide benchmark is also possible. Furthermore the Value Added Heat Map can be applied to analyse and benchmark the information flow in service companies. The benchmarking could be carried out for cross-industry comparison of business service and production sectors.

#### 5.3. Transfer the Value Added Heat Map to other Production Relevant Factors

The Value Added Heat Map by Schröder and Tomanek has been applied so far to production relevant factors like space usage, traffic load and information flow. This methodology can be adapted easily to other factors. Possible example to apply this method in future could be the equipment utilization in manufacturing companies.

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# TOTAL LOGISTICS MANAGEMENT CONCEPT AND PRINCIPLES IN MANUFACTURING ENTERPRISE

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### Abstract

Strong dynamics of social, political and economic changes in 21st century generates new problems the citizens, politicians and managers need to face. Significant increase in the variety and scale of the problems has been evident in the economic sphere, particularly in case of manufacturing companies. It resulted in the continuous search for better solutions to be implemented in company organization and management.

The analysis of academic studies in logistics indicates one of the serious issues is the existing knowledge implementation and its long-term improvement. Lean Supply Chain, Agile Supply Chain, Leagile Supply Chain, Flexible Supply Chain, Resilient Supply Chain, Green Supply Chain are some of the new concepts developed for the complimentary use in logistics. The legitimate questions arises whether the above-mentioned logistics management concepts could be combined into one coherent idea called Total Logistics Management.

The article presents the concept and assumptions of Total Logistics Management used as the 21st century manufacturing company management perspective.

Key words: concept, logistics, management, company, TLM

# **1. INTRODUCTION**

The range of theoretical and practical academic studies in manufacturing enterprises management in 20th century is exceptionally wide. Concepts of Lean Management, including Lean Manufacturing (LM), Flexible Manufacturing Systems (FMS), Just in Time method (JiT) used in Toyota Production System (TPS) had an enormous impact on the companies operation at the end of the 20th century. Simultaneously, the need for continuous quality improvement was acknowledged. Total Quality Management (TQM), SiX Sigma and quality management standards developed by the International Organization for Standardization (ISO) are the best examples. The application of specific tools related to the above-mentioned concepts, such as waste reduction (Muda), Value Stream Mapping (VSM), 5S practices or the use of quality improvement methods and techniques, f. ex. Quality Function Deployment (OFD), Failure Mode and Effect Analysis (FMEA) and SiX Sigma (DMAIC - Define, Measure, Analyze, Improve, Control or DMADV - Define, Measure, Analyze, Design, Verify) are becoming insufficient to enhance company's competitiveness in the global market. Similarly, quality standards based on ISO, have become excessively bureaucratic tools which promote the organization's development to a lesser extent. The quality theory of "full customer satisfaction" put forward by Deming has been confronted by an economic challenge. Excellent products have not been replaced, thus decreasing the demand in the market. At the same time, facing the exceeding globalization process, many companies have realized the significance of the effective and efficient goods and information flow reflected in the Supply Chain Management (SCM) concept. It is worth noting numerous companies have adopted the presented organizational solutions as their standard procedures, however, they have not been able to address the 21st century challenges. The evolving Supply Chain Management following the 7Rs principle - right product delivered at the right quantity and condition to the right place at the right time and price to the right customer, (Shapiro & Heskett, 1995, p. 6), at the turn of the centuries, had to respond to the globalization consequences such as the offers individualization or extended networks between supply chain participants. It was an incentive to search for new organizational solutions which might rationalize and optimize the goods, materials, products and related information flow, providing the ground for the new logistics concepts development.

# 2. SELECTED CONCEPTS OF LOGISTICS MANAGEMENT IN MANUFACTURING ENTERPRISES

Based on the literature review, the following concepts related to the logistics management or supply chain management are currently frequently discussed:

- lean (management, manufacturing, supply chain, logistics),
- agile (management, manufacturing, supply chain),
- leagile (manufacturing, supply chain),
- resilient (supply chain),
- green (manufacturing, supply chain, logistics).

In order to give and overview of the issues connected with the above-mentioned concepts and incorporate them adequately into the TLM philosophy, their key elements will be briefly discussed.

The first concept discussed, Lean Logistics, is deeply rooted in Lean Management and Lean Manufacturing principles. Lean Thinking idea was developed by Womack and Jones in their book of the same title (Womack & Jones, 2001, p. 27). Toyota Production System, based on TQM philosophy, and JiT method (transferred to any production type, including unit and low-volume production) provided the foundation for their considerations. They also highlighted concepts such as: value (value stream), flow, waste and excellence/perfection. Another Lean concept key element is the change from "push" production system based on forecasts to "pull" production system based on actual customer needs. On that basis, a number of "lean

thinking" elements have been transferred to logistics. According to Hines, Jones and Rich, Lean logistics is based on TPS, implementing extended TPS principles throughout the whole supply chain from the customer to the raw materials and materials necessary for production. As the authors point out, Lean Logistics key words are identical as the above-mentioned TQM philosophy key concepts: value, value stream, flow, pull system and excellence (Jones et al., 2004, p. 153-156). The authors' explicit reference to excellence indicates a great impact of TQM and continuous improvement KAIZEN philosophies. Therefore, it seems Total Logistics Management concept assumptions should include selected TOM elements. Additionally, the same authors, referring to the book by Womack and Jones (1996, p. 12, 129, 134) developed an idea of lean thinking in logistic processes, i. e. lean manufacturing, lean storage, lean orders handling, which could be naturally followed by lean packaging or lean transport. Swamidass (2000, p. 346) defines Lean Logistics as the Lean Management philosophy principles implementation into supply chain processes. The statement could be extended to functional and phase logistics division. Therefore, Lean Logistics philosophy is an implementation of principles connected with waste reduction, value creation, flow improvement, pull production system, striving for perfection in all logistics phases (supply, manufacturing, distribution, disposal and returns) and functions (transport, storage, inventory management, orders handling, packaging) in the enterprise. Lean Logistics refers to the idea of Lean Supply Chain, which focuses on the waste reduction at every supply chain phase. In many cases Lean Supply Chain is presented as the logistic chains strategy (Goldsby et al., 2006, p. 58), however, having analyzed the above-mentioned facts, one might challenge this approach.

Whereas Lean-based management concentrates on generating maximum output value while reducing any waste, Agile management focuses on increasing efficiency, flexibility to adjust to the customer needs as quickly as possible.

Agile management or manufacturing is strongly related to the supply chain flexibility. The concept of Agile Supply Chain was defined by Harrison and van Hoek (2010, p. 273). They indicated four basic agile supply chain dimensions:

- client orientation (market sensitivity), understood as the ability to identify and satisfy the actual customer needs,
- partnership in relations (partnership cooperation) among all supply chain participants understood as joint and compliant cooperation of the supply chain participants,
- process approach to supply chain (processes integration), interpreted as combining and integrating all supply chain business processes into one coherent system,
- IT use in supply chain (virtuality), promptness, accuracy and efficiency of the information transferred becomes the key to the whole system flexibility.

Saadoon Al. Samman (2014, p. 1093) claims that agile manufacturing, the basis for agile supply chain, should indicate the following features:

- high quality and high adjustment level to the customer needs (customization),
- high information availability related to the products and services and added value maximization,
- key competences absorption,

- sensitivity to social and environmental issues,
- use of numerous technologies combination,
- capability to respond to a volatile and multidimensional demand,
- internal and external enterprise integration.

The same author pointed out some of the basic advantages of Agile manufacturing which include: prompt and effective response to the customer needs in the changing market, ability to adjust and deliver the products according to the customer needs, the ability to produce and deliver new products while optimizing costs, decreasing manufacturing costs, increasing customer satisfaction, higher competitiveness, reduction of no-added-value processes.

The decision which concept (Lean/Agile) should be superior, in the view of presented Agile supply chain and Agile manufacturing dimensions, is challenging. It should result from the concepts comparison and identifying key differences between them. Additionally, such comparison should facilitate understanding the assumptions behind the Leagile Supply Chain concept.

Christopher (2000, p. 38-39) performed the comparison and recommended Lean concept for high-volume and mass production, with little product diversity and predictable environment. Agile concept, according to Christopher, should be dedicated to more dynamic environment, with the tendency to an increased product diversity. In his opinion, a crucial barrier for the company to experience full benefits of Agile concept is product diversity caused by the extensive marketing activities. The synthesis of both concepts inevitably leads us to the Leagile concept presentation.

Leagile supply chain concept was accurately defined by Mason-Jones, Taylor and Towill (2000, p. 4064). They define Leagile concept as a combination of lean and agile concepts in supply chain management. It is based on material decoupling point, the furthest in material flow to which the customer orders can reach. In other words, it is the place where the orders handling-related activities (demand) meet manufacturing-related and forecasting activities. Saadoon Al. Samman (2014, p. 1094) claims the decoupling point is a place where manufacturing efficiency and effectiveness are more important than other supply chain elements. Mason-Jones, Taylor and Towill indicate that demand-driven processes should follow Agile philosophy principles, forecasting activities should rely on Lean philosophy principles, thus creating Leagile idea. The authors also highlight the Lean processes direction which, according to pull production system concept, should be opposite to materials flow – pulling in the goods from the system in a way that the Agile concept processes follow the same direction as the materials flow. This should ensure meeting the diversified market needs. Leagile concept is a lean, flexible response with a given product to volatile customer needs at the turbulent market acquired by lean processes used to manufacture the product. It clearly shows the Leagile concept's dichotomous nature of lean production and agile response to customer needs (not necessarily based on Lean philosophy) (Pietroń et al., 2016, p. 48).

Another concept that deserves to be discussed is the Resilient Supply Chain (RSC) Christopher and Peck (2002, p. 2-3) describe it as constantly developing branch in management studies. They define resilience as the system ability to return to its initial state or new, desired state after the negative processes that influence the system have been eliminated. The resilience is strongly related to risk. Deloitte (2013, p. 6)

determines the need to create Resilient Supply Chains addressing the following risk types:

- macro environment risk (resulting from globalization and gaining access to new markets which increases the supply chains complexity and vulnerability to issues such as natural disasters, political turmoil or economic crises),
- extended value chain risk (resulting from outsourcing and core competences issues dependence on suppliers and sharing outsourcing and commissioning risks),
- operational risk (resulting from enterprise internal processes and their risk development, planning, manufacturing, distribution, returns and resources),
- functional risk (relating to the business functions that support supply chains, such as Finance, Human Resources or IT).

In the same Report Deloitte proposes four key pillars of Resilient Supply Chain: visibility, flexibility, collaboration and control. In fact, the key attributes of Resilient Supply Chain could easily become a foundation for any supply chain. All four pillars, supported by processes, human resources and technology, constitute the Resilient Supply Chain concept.

Bukowski (2012, p. 530) presents RSC as a supply chain management strategy aimed to reduce risks within the entire supply chain and the enterprise itself. He indicates a number of the concept's characteristic features such as demand-adjusted supply chain design, creating alternative ways, supply chains reduction, taking dependability into account when designing supply chains, increasing inventory and pace of goods transfer in the supply chains, generating spare capacities in the process, partners' collaboration and trust, the use of decoupling point initiating the Agile and Lean concepts implementation, relations management with the suppliers, processes standardization and unification and visibility understood as information availability for all supply chain participants. Bukowski points out there is a threat when implementing Resilient concept to reduce the existing supply chain efficiency where the processes are stable and predictable. Another study by Shefei and Rice defines RSC as capable of responding to unexpected situations and restoring the regular functions (Shefei & Rice, 2005, p. 41). Bukowski and Feliks (2012, p. 529) stress the RSC concept's multidimensional context. They concentrate on the dependability qualitative definition (in terms of resilience) which includes the idea of trusted (reliable) services supply. Interestingly, such dependability definition has been so far rather used in the Information Technology and computer sciences.

Original approach to supply chains safety measurements was presented by Rice and Caniato (2003, p. 24). They notice the companies usually refer to safety measures undertaken in three areas: physical, information and transport.

The literature review of RSC concept leads to a conclusion it has become one of the most widely discussed and dynamically developing issues in logistics. If we combine it with the issues of company security in 21st century it will definitely remain the key element of logistics management.

The final concept to be presented is called Green Logistics (GL) or Green Supply Chain Management (GrSCM), a pro-ecological logistics management concept. According to Srivastava (2007, p. 53) the increased significance of GrSCM directly stems from the deteriorating environment condition reflected in lower supply of raw materials, excessive waste and increased pollution levels. The author sees GrSCM as a natural consequence of the evolutionary change in manufacturing companies which replaced a reactive approach to environment management based on developed programs with a more pro-active approach reflected in "various Rs" principle:

- Reduce,
- Re-use,
- Rework,
- Refurbish,
- Reclaim,
- Recycle,
- Remanufacture.

Green Supply Management concept is in fact a combination of environment management and supply chain management. The scope of GrSCM definition is extensive. The notion "green" (meaning eco-friendly) has been assigned both to purchasing and integrated supply chains which forward the goods from the suppliers via manufacturers to the final customers (Zhu & Sarkis, 2004, p. 266). Srivastava (2007, p. 54) defined Green Supply Chain Management as an integrated environmental thinking within the framework of supply chain management which includes product design, search and selection of materials and raw materials for the given product, manufacturing and delivery to the final customer, pro-active approach to exploited product – Reverse Logistics. It is important to note here the notion of "green design" which takes environmental aspects into account throughout the whole product life cycle. This enforces a multivalent approach to product design which takes into consideration issues of environmental risk management, occupational health and safety, rational materials use or waste reduction.

Green Logistics concept has been defined in a wider company strategic perspective. Sbihi and Eglese (2007, p. 99) claim Green Logistics focuses on goods manufacturing and distribution related to sustainable development idea which considers social and environmental factors. Not only do logistic processes economic aspects matter but also their widespread impact to the society. Additionally, the authors argue any GL activities should include the environment impact measurements of the distribution strategies used, minimizing energy use in logistic processes, waste reduction and precautionary measures undertaken.

It is clearly seen both GrSCM and GL concepts have roots in Lean philosophy and Resilient Supply Chain concept, particularly in the areas of security, safety and risk (although from a different perspective). Such similarities and differences become a perfect foundation to define the basic assumptions of the total company management through logistics.

The discussed logistics management concepts differ slightly in the essence and the comparison between all of them might be difficult. Agarwal, Shankar and Tiwari (2006, p. 212) compared Lean, Agile, Leagile Supply Chain concepts according to the following criteria – Table 1.

Table 1. Comparison between Lean, Agile, Leagile Supply Chain concepts					
	Lean	Agile	Leagile		
Market demand	Predictable	Volatile	Volatile and		
			unpredictable		
Product range	Low	High	Medium		
diversity			(Optimized)		
Product life cycle	Long	Short	Short		
Buyers preferences	Cost	Lead time and	Service quality		
		availability			
Dominant costs	Actual	Costs to	Actual operating		
	operating costs	maintain market	costs and costs to		
		availability	maintain market		
			availability		
Ways to make the	Long-term	Immediate and	No possibility to		
products available	contracts	changeable	run out of stock,		
			permanent		
			availability		
Purchase policy	Goods purchase	Suppliers	Purchase		
		capabilities	management by		
		management	the supplier		
Information	Highly desired	Essential	Significant		
enrichment					
Typical goods	Goods	Fashion goods	Customer-		
			adjusted goods,		
			Customized goods		
Lead time reduction	Significant	Significant	Desired		
Waste reduction	Significant	Desired	Optional		
Relations stability	Optional	Significant	Desired		

Table 1. Comparison between Lean, Agile, Leagile Supply Chain concepts

Source: own work based on (Agarwal et al., 2006, p. 212)

As can be seen in the Table presented, the authors indicate a number of approach differences between Lean and Agile concepts. They also highlight where Leagile concept draws the most from Lean and Agile Supply Chain concepts. The authors confirm that supply chain "leanness" in certain conditions can be an element of "agility", at the same time it impedes the organizations ability to meet the customer needs promptly. It is important to note that the criteria selected by the authors are mainly based on two operational elements – meeting the customer needs and the elements characteristic to those activities as well as the processes operationalization which leads to meeting the needs. In particular, the last four items, i.e. quality, cost, lead time and service quality level are only partly realized to the benefit of the customer and three quarters become an element of the market supply-demand "game" and are controlled by the market hidden hand.

From the presented table we can see that the "agility" concept mainly refers to fashion goods for which style and originality are more important than price. This in turn suggests Leagile concept should address the precise customer needs in accordance with the market supply, therefore the product range should be highly customized and the offered service quality should be a major concern. It seems that the comparisons included in Table 1 are somewhat in their extreme, as in case of forecasting mechanisms.

It indicates Lean Supply Chain concept is based on algorithmic supply forecasts which is more relevant to push manufacturing system rather than pull manufacturing systems (an integral part of Lean concept). Similarly, determining supply as predictable for Lean and unpredictable and volatile in case of the two remaining concepts seems unjustified. Supply predictability in Lean concept is a result of its "manufacturing" approach to the offered product range rather than concentrating on goods aimed to meet any possible imaginable customer needs. These concerns do not impact the importance of the comparison in the attempt to define the assumptions of Total Logistics Management concept (Pietroń et al., 2016, p. 52).

The criteria selected by the authors make it difficult to include Resilient Supply Chain and Green Supply Chain into the comparison. In many cases they constitute an additional criteria supplementation. It proves the Total Logistics Management multidimensional character which results from the complexity of conditions in which modern logistics and supply chains operate nowadays. In the author's opinion, the discussed concepts seem insufficient to define thoroughly the Total Logistics Management.

### 3. TOTAL LOGISTICS MANAGEMENT

The review of selected Logistics Management concepts may serve as the basis to define the assumptions of Total Logistics Management (TLM) concept. At the same time, there is the need to perform a literature review of the studies which discussed the issue.

Bukowski is one of the Polish authors who covers the TLM issues and his findings are worth mentioning. He maintains (Bukowski, 2014, p. 1709) the essence of Total Logistics Management concept should be based on a combination of three dominant concepts in Logistics Management, namely Lean, Agile and Resilient. One needs to notice that part of those concepts - Table 1 are contradictory in nature which might impede the attempt of complete and systematic Total Logistics Management conceptualization. The author justifies his approach by formulating the main strategic and operational goals in supply chain and they are the rational risk management and supplies continuity in his opinion, with such goals defined, the issues of safety and security, dependability, survivability and resilience needs to be taken into special consideration. However, it should be noted, his TLM definition ignores two significant aspects: ecological aspect addressed within the framework of Green Logistics concept and Leagile Logistics concept. What is more, there are other fundamental areas in company management, for example, quality management, which have strong impact on the TLM concept. With his approach one can assume TLM concept puts Logistics and Supply Chain management in the sphere of operational company management.

If we adopt a different view of the TLM concept seen as a strategic tool in company operations, similarly as the idea of global logistics, we can find numerous references in literature. Kotabe and Helsen (2010, p. 322) define global logistics as a designed and managed system in which managing and monitoring the goods and information flows takes place in three dimensions: internally within the organization, by the organization and externally at the global scale. The whole system is aimed at the strategic goals achievement at the lowest possible total cost. It is difficult to achieve due to regional differences concerning transport, storage, packaging, orders handling and inventory managing. It requires taking a strategic look at the company.

The assumptions of the TLM concept first need to be embedded in Logistics Management and Supply Chain Management concepts either in the view of the enterprise's strategic/operational functioning or its functional/process categories.

If we take a closer look at the TLM concept proposed by Bukowski we can clearly distinguish internally and externally integrated operational approach to logistics characterized in functional/process categories for the whole company. Obviously, strategic decisions on adopting Lean, Agile, Leagile or Resilient concepts are crucial for the company, however, they concern only company logistic functions and they should not enforce other organization processes subordination to logistics. Purely operational and slightly process approach has been adopted by the Global Logistics Excellence authors. Similarly to TLM concept, strategic choices are limited to key supply chain elements, regarded as one of the organization management aspects – a more functional approach. In both cases the organization searches for solutions optimizing their activities with respect to 7Rs (right product, client, price, place, amount, quality (condition), logistic activities). Logistics does not become a superior element of the business model creation but is one of the functional areas which undergoes management processes (Pietroń et al., 2016, p. 61).

It seems that Global Logistics Management or Global Supply Chain Management enforces a different look at the company's logistic issues. For many enterprises marketing-supported logistics should become a strategic operating element and other company operations are subordinated. According to this approach, TLM should be defined as the realization of all organization operations and processes in order to obtain an effective and efficient goods and information flow. The subordination should not have a "monopoly" character. Logistics (effective and efficient goods and information flow) should be the main and superior assumption in the company functioning. Two dimensions of the phenomenon need to be indicated here. The first one concerns the physical flow of goods and information beginning from the raw materials, through manufacturing and final customer to reverse logistics. The other concerns the products and services development from the logistics perspective. Neither of the two presented approaches undermines the existing practical and theoretical knowledge. They are complimentary and constitute a new and more mature stage in the logistics development within the organization.

The second assumption seems particularly important. The product design processes are key elements in this Total Logistics Management definition. Quality Management concept mainly focuses on continuous processes improvement, however, the very product is equally important. In many cases it is modified to meet the requirements of internal and external clients. The care about the external client satisfaction is obvious, whereas the conceptual product design which takes into consideration process and staff needs reflects the enterprise's maturity and high organizational culture (Bielecki & Szymonik, 2013, p. 5).

Similarly, in Logistics Management and Integrated Supply Chain Management, the very product, with respect to its properties and features, is of great importance. Depending on the possible range in design changes, the appropriate strategy can be selected. Bielecki (2013, p. 176) proposed two strategy types: conceptual and adjustment, both related to the same product. In case of adjustment strategy, there are few possibilities to implement changes in the product and this, in turn, determines the necessity to use the adjustment logistics management (effective and efficient is limited to specific logistic activities optimization). As for conceptual strategy, it is oriented to new products and processes development in terms of logistics, the product role is stressed and the notion of logistically efficient product appears.

Logistically efficient product is defined as a material object in market exchange characterized by a set of properties and features which enable an effective and efficient internal and external flow of the product itself and the related information in the spheres of supply, manufacturing, distribution, disposal and returns. The properties and features at the internal level allow for an effective and efficient integration of IT, transport, storage, packaging, inventory management, order handling processes within the framework of an Integrated Supply Chain Management concept. Logistic product efficiency enforces an inquisitive product analysis and a selection of an appropriate strategy: conceptual or adjustment and the use of relevant methods, techniques and tools to adapt the chosen strategy to the market conditions.

Neither of the two options should, however, impact the Total Logistics Management underlying assumptions. Bielecki and Szymonik (2015, p. 31) formulated 6 Total Logistics principles. They have been slightly modified and amended by the author and are presented below:

- 1) Logistic quality guarantees full customer satisfaction and continuous logistic quality improvement and supply chain optimization should become a routine.
- 2) The pursuit of logistic partnership is based on professionalism and trust.
- 3) The safety and security assurance for people and goods and information flows
- 4) The pursuit of "one click" activities implementation based on flow processes automation and computerisation.
- 5) Sustainable logistics development ensures an appropriate organization's impact on its environment.
- 6) Total Product Management based on product logistic efficiency is the foundation to secure effective and efficient goods and information flow.

All the above-mentioned principles have been briefly discussed and justified below.

Logistic quality is the first notion used in the TLM concept. Naturally, logistic quality should be interpreted in the view of the previously mentioned 7Rs principle, which is described in detail by Szymonik and Bielecki (2015, p. 31). It seems, however, logistics quality should be closely related with three basic Logistics or Supply Chain Management elements: product, processes, relations. Referring to the first element, in the initial phase of product design, to ensure the product is innovative,

no boundary conditions should be imposed on the designer. In the next phase the concept should be challenged in the view of four basic dimensions: marketing, manufacturing, quality and logistics. If we adopt TLM concept, logistics criterion should be superior, however, there should a common ground for all areas. The developed product should be right for the customer (the customer wishes to purchase the product), "easy" to manufacture, allowing to meet quality standards and flow effectively and efficiently through all the logistic phases in the supply chain (supply, manufacturing, distribution, disposal and returns (Pfohl, 2010, p. 17-19). Development of such products, in many cases, will not be possible. The concept, however, highlights the close relationship between various organization and management functions. Logistics quality in the process context aims to quantify the designer's idea on the basis of 7Rs principle. Organization must adopt knowledgebased management assumptions in which every process is modelled with an active participation of stakeholders and the emphasis is put on waste reduction and added value. Continuous collaboration and logistic quality improvement borrowed from Kaizen, Logistics Small Group Activities (LSGA) within the company and collaboration with suppliers in the form of Supply Chain Group Activities should result in internal and external customer satisfaction (Pietroń et al., 2016, p. 64).

Partnership and professionalism in supply chain constitute the second principle of the TLM concept. Ellram and Cooper (1990, p. 4) define strategic collaboration between supply chain participants as a collaboration within the framework of determined goods and information flow channels where the main aim is to obtain diversification and benefits for all supply chain elements in medium and long-term perspective. The same authors argue this collaboration type is future-oriented and relies on the mutual trust. The partners share information, risks and benefits of joint operations/activities. Main advantages of this approach include benefits for the suppliers, economic benefits resulting from shared risks, reduced costs, increased quality level, managerial and strategic benefits. Trust is also often indicated as the key element in Deming's TOM concept (Latzko & Saunders, 1995, p. 78), among the organization weaknesses he points out the emphasis on the short-term profitability, lack of persistence to act consequently and high legal costs which are usually a starting point in any collaboration between organizations. Professionalism is another important issue to be concerned. Greenwood (1957, p. 45) describes a professional using four features. It is a person who always acts based on their knowledge, sociallyrecognized authority and ethical principles governing the relationships within the society and among the clients and it occurs within an organization with a professional organizational culture. Leadership plays an important role in TQM concept and is also vital, at a bit smaller extent, in Total Logistics Management concept.

The third basic element of Total Logistics Management concerns the implementation of modern technologies in the aspects of material processes and information. Obviously, this point should not be regarded as an incentive to implement specific activities but as an encouragement to apply an innovative approach of "one click" concept. The idea was developed by Ericsson company based of their telecommunications services market research. The concept, described in the report, is based on the client expectations in their mobile devices use. They expect to have the "step-by-step" procedures simplified without any unnecessary options. It is

a challenge that undermines the current organizations' approach to the issue. It enforces the management and data synchronization within the internal and external organization integration. "One click" concept in Logistics and Supply Chain Management should be supplemented further. One click should generate one activity that gives a specific added value for the company and the client in the whole logistic chain. Automation, bar codes and constantly developing Radio-frequency identification technology (RFID) should become the tools for effective "one click" concept implementation.

Another basic element in Total Logistics Management concerns sustainable approach to logistic aspects which guarantees the right supply chain impact on the widely-understood environment. According to Sadowski (2008, p. 129) practical aspect of sustainable development is based on integrated governance where ecological, social, land, institutional and political aspects become the superior spheres of politics and management. Therefore, sustainable approach to logistics should be founded on two key areas:

- ecological supply chain optimization concentrated on the goods and information flow from the raw material acquisition to the delivery to the final client,
- the use of Reverse Logistic concept interpreted as (Rogers & Tibben-Lembke, 2001, p. 130) the activities that are encompassed in traditional logistics concept but the emphasis is put on their reverse operation.

Rogers and Tibben-Lembke define Reverse Logistics as the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, inprocess inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. Therefore, it seems accomplishing the logistics ecological aspect and the use of Reverse Logistics might become one of the biggest challenges for the researchers and practitioners in the coming decades. It is important to note that nowadays the consumption goods generally are not designed in a way to facilitate future value recapturing or proper disposal of the used goods. Product designs often assume waste and strengthened consumption rather than rational management. This creates a space for the product and its total management in the Total Logistics Management concept.

Product logistic efficiency and related issue of total product management have been defined on the basis of the author's own research. Logistic product efficiency or logistically efficient product was defined by Szymonik and Bielecki (2015, p. 41) as a material object of market exchange possessing specific properties and features which allow for the effective and efficient internal transfer of the product and related information through supply, manufacturing and distribution phases, and externally enable to integrate effectively and efficiently processes of storage, transport, packaging, inventory management, handling orders within the concept of Total Logistics Management. The product logistic efficiency additionally contributes to achieve goods and information flows coherence between all supply chain participants. The idea of product logistic efficiency has been extended and also includes the issues of the design, transport, storage and organizing adaptability which might become the basis for the product logistic efficiency appraisal. Total Product Management should be closely related to the product logistic appraisal and become the foundation for the appropriate logistic strategy adoption (Bielecki, 2013, p. 180). High product design adaptability in the supply chain enables to choose conceptual logistic strategy, the approach where the product, the processes necessary to form and withdraw it from the market (Reverse Logistics) can be precisely planned at the design stage. However, there is a group of products with low product design adaptability (the properties and features are impossible to modify due to legal, economic or market reasons). In such situation the adjustment logistics strategy should be adopted and Total Logistics Management is then based on continuous current processes improvement and the search for innovative ways to implement Total Logistics Management concept.

The presented assumptions are summarized in the conclusions as well as the directions for the future authors' research.

### 4. CONCLUSION

The assumptions of Total Logistics Management concept remain closely interrelated. The product analysis and logistics strategy choice (between conceptual and adjustment strategies) are crucial starting points when implementing Total Logistics Management concept. Both strategies are acceptable in TLM approach, however, the conceptual logistics strategy has higher potential to implement more innovative approach to Logistics Management. This does not necessarily make the implementation of Total Logistics Management impossible in case of low design adaptability products (f. ex. a building brick with standardized dimensions). In such cases, the continuous Logistics company culture. If the company does not strive for continuous logistics improvement and Total Logistics Management principles implementation, it should adopt a passive approach in the context of Logistics Management. It refers to corrective actions in logistics processes which allow to reduce problems resulting from wrong decisions taken in the spheres of logistics and supply chains.

Proper product management means considering the mass production aspect and product range limitations accompanied by a high customization rate. The first two parameters let optimize logistics stages (supply, manufacturing, distribution, disposal and returns) and logistics functions (transport, storage, inventory management, orders handling, packaging). The third parameter is responsible for the customer satisfaction.

A thorough product analysis allows to build a logistics system based on TLM assumptions. The system should be purposefully designed and organized around the available human, material, financial and information resources taking into consideration people and goods and information flows security and safety, as well as the automation of goods and information flows with the use of "one click" type activities. The system should be based on sustainable logistics development where the pursuit of logistics partnership built on professionalism and trust creates logistics quality that guarantees full customer satisfaction.

Further authors' studies shall focus on the issue of Product Logistic Efficiency, its impact on Total Logistics Management concept and phenomena such as customization and modularity.

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# THE ANALYSIS OF PRODUCTION LINES BOTTLENECKS – IDENTIFICATION AND WAYS OF MANAGEMENT

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### Abstract

Insufficient and limited production capability is a common problem faced by production enterprises nowadays. The production processes management is continuously improving. Theory of Constraints (TOC) is an interesting concept of planning and controlling production. TOC is a simple and most importantly, a very effective technique of production systems management.

The aim of this article is to present the possibilities offered by the application of TOC in practice. The first step in investigating the production system under analysis was identifying bottlenecks in two production lines. Improvement proposals were presented for each line.

The subject of the study is an existing automotive enterprise producing a variety of components. This article analyses two production lines. LP01 - a production line which produces only one product and LP02 which produces many different products. The authors' research method was employed - based on the analysis of i.e.: tact time, productivity and the level of machine exploitation, profit margin.

The explorations of the authors do not exhaust all the other possible variants of improvement in production systems managed with TOC logic. The presented ways of proceeding are designated to support production managers in decision-making processes. Reducing the impact of bottlenecks to a minimum entails independence from constraints. Due to such operations production processes will be much more productive.

**Key words:** production line, theory of constraints (TOC), bottleneck, productivity, automotive industry

# **1. INTRODUCTION**

According to the theory of constraints (TOC), the central task of effective production management is to find and eliminate the impact of a bottleneck in a company. A bottleneck is an element of resources (e.g. a job position) with the lowest potential (production capacity). It marks the capacity of the entire production system. Production system capacity is a crucial element of manufacturing companies competitive advantage. It has an influence on company's costs and ecological issues (Kolinski, 2017, pp. 161-177).

Taking the occurrence of bottlenecks into account, production management may be divided into (Koliński & Tomkowiak, 2010, pp. 16-17):

- management in a situation with no bottlenecks in the production process,
- management in a situation with one bottleneck in the production process,

- management in a situation with many bottlenecks in the production process,

The absence of bottlenecks in the production process means that the production productivity is enough to achieve forecast sales. If one bottleneck occurs, it needs to be determined whether there is only one production process or whether alternative production processes are possible. Contribution margin analysis for individual combinations of products and processes is a useful tool in this case. If it turns out that there are several parallel bottlenecks in the production process, the decision becomes more complex. In such an event, solutions to these problems should be seeked with the use of linear programming methods.

# 2. THE THEORY OF CONSTRAINTS AS AN EFFECTIVE TOOL OF ANALYSING BOTTLENECKS IN THE PRODUCTION PROCESS

The theory of constraints was formulated by Dr. Eliyahu M. Goldratt, an Israeli physician. He applied the methods of exact sciences to improve the functioning of business companies. The theory of constraints was created in the 1970s. Its concept has been developing through the years. It initially focused only on selected functional areas of companies, such as production, whereas presently it is used for the purpose of managing an entire company, or an entire supply chain. Described above trend is strictly connected with integration of supply chain (Cyplik et al, 2014, pp. 4465-4470; Hadas et al, 2015, pp. 225-239).

In 1984, E. M. Goldratt published a book describing the DBR (Drum-Buffer-Rope) method – one of the tools used by the theory of constraints (Goldratt & Cox, 1984). An example of implementation of TOC in production area was described in paper (Cyplik et al, 2009, pp. 1-12). In his new book, published in 1990, Goldratt extended the theory of constraints with the possibility to make measurements in selected production processes (Goldratt, 1990). In 1994, the second part of his bestselling book "The Goal", which presented the possibilities of applying the TOC concept in other areas of company operations at the strategic level (Goldratt, 1994), was published. 1997 marked the publication of Goldratt's next book, "Critical Chain", showing the use of tools of the theory of constraints in the area of project management (Goldratt, 1997). In 2004, G. I. Kendall's book, describing practical application of the theory of constraints in an entire company, was published (Kendall, 2004).

The basic assumptions of TOC are as follows (Hadaś et al, 2012, p. 93):

- each system has a goal,

- a system is expected to improve its achievements (related to the goal),

- achievements of every system are limited with constraints.

Thus, the theory of TOC assumes that every system has at least one constraint. According to these assumptions, smoother delivery of a system's goal depends on the removal of the constraint which prevents its achievement. Efforts should therefore be focused on the constraint, defined as every factor which prevents the system from achieving better results, such as profit.

TOC defines a set of tools which may be used to control and manage constraints and, consequently, increase profit. One of the basic tools is the five focusing steps method. Its essence lies in continuous perfection of the system. In relation to the fact that TOC sees a production system as a chain whose strength depends on the strength of its weakest link, the method assumes focusing attention on the point where maximum effect may be achieved, namely on the system's constraint.

As part of step 1 (identify), the constraint must be identified. In a production company, there is always at least one resource that will constrain maximum productivity. Inside the company, there may be one or more work stations forming a constraint (the so-called critical resource). Identification of a bottleneck in a production process is not a difficult task – as early as at the stage of planning (balancing of loads) it is possible to indicate positions with the highest load (close to 100% or above it), which may represent a constraint. Identifying a constraint marks the start of actions aiming at improving the situation.

As part of step 2 (exploit), a decision on how to exploit the constraint must be made. Everything that causes the waste of time of this resource's work, i.e. disrupts the continuity of its work, should be eliminated. At this stage, streamlining the work of the critical resource is of organisational nature, e.g. adapting employees' breaks so that they do not cause a break in the constraint's work, without incurring any extra costs. An important rule should be taken into account: an hour lost in a bottleneck is an hour lost in the entire system.

Step 3 (subordinate) concerns subjecting all decisions to work and the constraint's productive. It should be borne in mind that effectiveness of the production process depends on undisturbed work of the bottleneck. It results in the planning of all activities ensuring the continuity of the constraint's work. All the resources should therefore work according to the rhythm of the critical resource, while their production volume should not be higher than the constraint which limits throughput.

Step 4 (elevate) focuses on improving the bottleneck's work productivity, as it is the only activity which influences the growth of productivity of the entire production process. There is a number of ways to achieve this goal: purchase of additional resources performing operations which form a constraint; change of technology, which will result in lowering the load of the critical resource; outsourcing. The step usually forces an organisation to incur additional costs.

As part of step 5 ("go back to step one"), which is the last step, an analysis if the constraint has been eliminated is carried out. If it has, step 1 should be taken again to identify a new constraint. The purpose of the last step is to continually strive to improve the system (Hadaś et al, 2012, pp. 94-96; Woeppel, 2009, pp. 14-20). The five focusing steps method will be applied in practice in sections 4-7 of the article.

# **3. CHARACTERISTICS OF THE OBJECT OF RESEARCH – A SELECTED PRODUCTION COMPANY**

The company is one of the world's leading manufacturers. It applies different types of solutions used in numerous car brands produced all over the world, such as Volkswagen, Honda, Ferrari, Fiat, Toyota, Chevrolet, Mazda, General Motors, Lexus and many more. Its product portfolio includes shock absorbers, batteries, radiators, condensers, evaporators and air-conditioning systems.

The company has its branches in 36 countries. It owns 159 production plants and 41 joint-venture production plants. In also operates 53 customer service centres and 33 technical inspection centres.

The company started its operations in Poland in 1994. It already has 4 factories located in Gdańsk, Błonie, Jeleśnia and Kraków. The company's technical centre is located in Kraków. Until recently, the company also had a branch in Ostrów Wielkopolski, which has been closed. Study results are based on data from this location.

# 4. ANALYSIS OF THE PRODUCTION PROCESS DEDICATED TO THE PRODUCTION OF ONE TYPE OF PRODUCT

The analysed production line LP01 consists of 12 work stations. Due to the fact that the line is dedicated to the manufacture of one product type (product A), in the production process a part of employees performs more than one operation. The layout of LP01 is therefore U-shaped.

In the analysed production company, operational data are defined as follows:

- ta – nominally available working time during one shift (480 min.),

- tc – cycle time, i.e. time of performing one operation for one item,

- ts – set-up time, i.e. time spent on preparing the station before starting work and on cleaning it up after ending work,

- tu – machine's unproductive time, providing for production downtimes (such as planned breaks, failures etc.)

The analysed production line manufactures product A during each of the three shifts in the form of mass production. Table 1 presents operational data concerning time for individual work stations.

Operation related to	Work	Operational data		
production	stations	Time	Value	
		tc [min]	2	
OP01	ST1	ts [min]	30	
		tu [min]	50	
OP02	ST1	tc [min]	5	
0102	511	ts [min]	30	

Table 1. Data of individual operations for production line LP01

I	1	1 1	
		tu [min]	35
		tc [min]	6
	ST2	ts [min]	50
		tu [min]	40
		tc [min]	3
OP03	ST1	ts [min]	10
		tu [min]	20
		tc [min]	5
	ST1	ts [min]	15
0.004		tu [min]	10
OP04		tc [min]	3
	ST2	ts [min]	30
		tu [min]	20
-		tc [min]	2
OP05	ST1	ts [min]	15
		tu [min]	22
		tc [min]	1
OP06	ST1	ts [min]	7
		tu [min]	40
		tc [min]	2
OP07	ST1	ts [min]	14
		tu [min]	32
		tc [min]	3
OP08	ST1	ts [min]	20
		tu [min]	15
		tc [min]	3
OP09	ST1	ts [min]	15
		tu [min]	40
		tc [min]	2
OP10	ST1	ts [min]	15
		tu [min]	15
		tc [min]	1
OP11	ST1	ts [min]	10
		tu [min]	10
		tc [min]	2
OP12	ST1	ts [min]	2
		tu [min]	0

Source: materials obtained from the company

Operations OP02 and OP04 re performed on two work stations. The productivity of these two operations should therefore be determined as a sum of productivity of individual work stations. Other operations as part of LP01 are performed by single work stations, which is why the productivity of these work stations is at the same time the productivity of particular operations.

The first step in analysing the bottlenecks of LP01 is to determine the productivity of particular operations. In the case of the first operation (OP01), there is one work station performing it. To determine the productivity of operation OP01,

productivity of the work station should be calculated with the use of the following formula (description of parameters – bullets at the beginning of the section):

$$P_{EO} = \frac{t_{d_i} - t_{pz_i} - t_{b_i}}{t_{j_i}}$$

The productivity of operation OP01 is therefore:

$$P_{EO_{OP1}} = \frac{480 - 30 - 50}{2} = 200 \ [szt]$$

In the case of operation OP02, we have two work stations, thus to determine the productivity of OP02, productivity of these two work stations should be summed up:

$$P_{EO_{OP2}} = \frac{480 - 30 - 35}{5} + \frac{480 - 50 - 40}{6} = 83 + 65 = 148 \text{ [szt]}$$

Productivity for the remaining stations is determined in a similar way. Table 2 presents a list of productivity of individual operation of production line LP01.

Operation related to production	Work stations	Station productivity [pcs/shift]	
OP01	ST1	200	
OP02	ST1	83	148
OF 02	ST2	65	140
OP03	ST1	150	
OP04	ST1	91	234
OF04	ST2	143	234
OP05	ST1	222	
OP06	ST1	433	
OP07	ST1	217	
OP08	ST1	148	
OP09	ST1	142	
OP10	ST1	225	
OP11	ST1	460	
OP12	ST1	239	

**Table 2.** Productivity of individual operations of production line LP01

Source: own study

Analysing the productivity of individual operations and bearing in mind the basic assumption of the theory of constraints which states that the productivity of the entire

production process is equal to the productivity of the weakest link, it should be stated that the productivity of production line LP01 is 142 pieces during one shift. Thus, it is reasonable for all of the operations to work in accordance with the bottleneck's productivity. As a result, most of the work stations will not have maximum load.

The degree of using particular operations is determined by the quotient of productivity of the whole production line (142 pieces) against the productivity of individual operations. For OP01, usage indicator is:

$$P_{OP01} = \frac{142}{200} = 70,83\%$$

For the remaining stations, the indicator is calculated in a similar way. Table 3 presents the degree of using individual work stations in production line LP01.

Operation related to production	Productivity of the station	Usage of the station
OP01	200	70.83%
OP02	148	95.95%
OP03	150	94.67%
OP04	234	60.68%
OP05	222	63.96%
OP06	433	32.79%
OP07	217	65.44%
OP08	148	95.95%
OP09	142	100.00%
OP10	225	63.11%
OP11	460	30.87%
OP12	239	59.41%

**Table 3.** Degree of using individual stations of production line LP01

Source: own study

A 100% usage of a work station which performs operation OP09 comes as no surprise, as it is an identified bottleneck of production line LP01, which should use its production capacity to the maximum. Despite unsatisfactory value of the production capacity usage indicator for individual operations (e.g. OP06), it should be borne in mind that increasing the degree of their usage may cause the generation of excessive stock (applies to all the operations located before the bottleneck), resulting in higher production cost. Lower usage of stations performing operations after the bottleneck (e.g. OP11) is caused by a much lower production capacity of the weakest link (the critical resource).

# 5. ANALYSIS OF THE PRODUCTION PROCESS DEDICATED TO THE PRODUCTION OF MANY TYPES OF PRODUCTS

Production line LP02 manufactures products characterised by a high degree of technological similarity. As a rule, all of the products manufactured on this type of production line are ordered by the same customer. Specific nature of the industry in which the analysed company operates and specific nature of products manufactured has a fundamental influence on production technology. As in the case of production line LP01, LP02 also consists of 12 operations, in accordance with specific features presented in Table 1. Due to the variability of products, each employee is assigned to one work station, and the production process is classically shaped. Production line LP02 manufactures 4 products which are technologically similar: product B1, product B2, product B3 and product B4. Forecast number of customer's orders for individual products is provided on a daily basis and does not change throughout the year. Operational data concerning the volume of weekly orders, margin of particular products and cycle times have been presented in Table 4.

	Product B1	Product B2	Product B3	Product B4
Forecast number of orders	70	110	60	100
Margin	100	200	150	75
OP01 [min]	2	3	1	2
OP02 [min]	3	2	2	3
OP03 [min]	2	1	2	1
OP04 [min]	5	4	4	5
OP05 [min]	2	3	2	3
OP06 [min]	1	2	1	2
OP07 [min]	2	2	2	2
OP08 [min]	3	4	3	3
OP09 [min]	3	2	2	3
OP10 [min]	2	3	3	2
OP11 [min]	1	2	2	1
OP12 [min]	1	2	1	1

**Table 4.** Operational data for production line LP02

Source: materials obtained from the company

The first step of analysing bottlenecks for this type of a production line consists in checking if the production line is capable of executing all of the orders in full. Cycle time for individual operations should therefore be multiplied by the volume of orders for particular products. Assuming 3-shift production (8h x 3 x 60 min = 1440 min), it

should be checked if all of the operations are able to deliver production in accordance with available time.

Daily OP01 usage time is:

For the remaining stations, the indicator is calculated in a similar way. Table 5 presents summary results for the identification of bottlenecks in production line LP02.

	Product B1	Product B2	Product B3	Product B4	Total
Forecast number of orders	70	110	60	100	340
Margin	100	200	150	75	-
OP01 [min]	140	330	60	200	730
OP02 [min]	210	220	120	300	850
OP03 [min]	140	110	120	100	470
OP04 [min]	350	440	240	500	1530
OP05 [min]	140	330	120	300	890
OP06 [min]	70	220	60	200	550
OP07 [min]	140	220	120	200	680
OP08 [min]	210	440	180	300	1130
OP09 [min]	210	220	120	300	850
OP10 [min]	140	330	180	200	850
OP11 [min]	70	220	120	100	510
OP12 [min]	70	220	60	100	450

Table 5. Identification of bottlenecks

Source: own study

Table 5 allows concluding that operation OP04 exceeds available time (1440 min) on one working day. It means it is not capable of manufacturing products meeting daily demand for individual products. Thus, the next step of analysing bottlenecks will consist in reducing the number of manufactured products in order to make maximum use of the weakest link. To this end, relative contribution margin must be determined:

relative contribution	_	contribution margin per piece
margin (RCM)	_	time of bottleneck usage

The value of relative contribution margin (RCM) presents the level of profitability of a given product. As a rule, the higher the value of this indicator, the

more cost-efficient the production of the particular product. The relative contribution margin (RCM) indicator for B1 is:

$$RCM_{B1} = \frac{100}{5} = 20$$

For the remaining products, the indicator is calculated in a similar way. Table 6 presents the RCM indicator for individual products.

	Product B1	Product B2	Product B3	Product B4
Forecast number of				
orders	70	110	60	100
Margin	100	200	150	75
OP04 [min]	5	4	4	5
RCM	20	50	37.5	15

Table 6. Relative contribution margin for individual products

Source: own study

Table 6 leads us to a conclusion that product B2 is most cost-effective, while B4 is least economic. Therefore, if it is obligatory to resign from a part of production, the least cost-effective part of production should be given up. According to the theory of constraints, with a defined bottleneck we focus on its work exclusively.

Thus, to reduce time spent on performing operation OP04, time of manufacturing product B4 should be decreased by 90 minutes (1530-1440=90). According to Table 5, 500 minutes a day is required to manufacture the entire order for product B4. Considering the need to decrease working time by 90 minutes, OP04 operation usage time should be reduced to 410 minutes. As Table 4 shows that the time of manufacturing one product B4 on operation OP04 is 5 minutes, with 410 minutes we may produce 82 pieces of B4 (410/5=82). In the present situation, the best solution will be:

- production of B2 in maximum order volume (110 pcs)

- production of B3 in maximum order volume (60 pcs)

- production of B1 in maximum order volume (70 pcs)

- production of B4 in the amount of 82 pcs.

Knowing the volume of orders for individual products, it is possible to calculate revenue:

$$P = 70 \times 100 + 110 \times 200 + 60 \times 150 + 82 \times 75 = 44150 \ [zl]$$

#### 6. IMPROVEMENTS IN PRODUCTION LINE LP01

Taking the specific nature of production line LP01 into account, first of all work stations should be evenly loaded (for an operation performed by more than one work

station), providing for the degree of operation usage. Only two operations from production line LP01 were performed by more than one work station. They were: - OP02.

- OP04.

Table 3 allows concluding that production capacities of OP02 are used in over 95%, whereas in the case of OP04 it is hardly 60%. It should be borne in mind, however, that the productivity of operation OP02 (148 pcs/shift) is close to the productivity of the bottleneck (142 pcs/shift), which makes it more probable that the operation may in the near future become a potential constraint. Table 7 presents a suggestion of even load put on both work stations performing operation OP02.

**Table 7.** Suggestion of even load put on both work stations performing operation

 OP02

Operation related to production	Work stations	Manufactured quantity	Degree of station usage
OP02	ST1	80	96.39%
OF02	ST2	62	95.38%

Source: own study

In the case of operation OP04, we are dealing with an insufficient degree to which production capacities of individual work stations are used. Table 8 presents a suggestion of even load put on both work stations performing operation OP04, providing for the current status of the machinery park.

**Table 8.** Suggestion of even load put on both work stations performing operation

 OP04

Operation related to production	Work stations	Manufactured quantity	Degree of station usage
OP04	ST1	55	60.44%
0704	ST2	87	60.70%

Source: own study

The degree to which both work stations performing operation OP04 are used may be considered insufficient. Accepting an assumption that production for stock is not cost-effective, the only way to improve the situation is to reduce the usage of work stations to one machine. In should be borne in mind, however, that in this specific case using station ST2 to produce 142 pieces will result in a nearly maximum (142/143=98.84%) usage of this work station's production capacity. It may create a risk of forming another bottleneck in production line LP01.

In the case of other operations, which are performed by one work station, the only suggested improvement was to take additional orders for performing this operation in collaboration with partners in the supply chain. In the case of operation OP12, i.e. product quality control, one may suggest to allocate the remaining time of

employees (unused in accordance with product A controlling scheme) to other activities aiming at streamlining production in production line LP01 (e.g. by the monitoring and control of machines manufacturing product A).

### 7. IMPROVEMENTS FOR PRODUCTION LINE LP02

In the case of production lines dedicated to manufacture a larger amount of products, improvements should be analysed in a different way. Considering the fact that the company's management decided not to buy new machines, the only suggested improvements are those of technological nature, which shorten the time spent on performing operations for individual products. The present section analyses the profitability of introducing technological changes suggested by company employees, according to the assumptions of the theory of constraints.

The planned undertaking assumed shortening the time spent on performing operation OP04 by 1 minute for product B1 (other data of the remaining operations have stayed the same – Table 4). Table 9 presents operational data for production line LP02 providing for the suggested change.

			00 1	
	Product B1	Product B2	Product B3	Product B4
Forecast number of				
orders	70	110	60	100
Margin	100	200	150	75
OP04 [min]	4	4	4	5

 Table 9. Operational data for production line LP02 - suggested improvements

Source: own study

Analysis of the data above allows brings us to a conclusion that the situation related to production will change only in the case of OP04. The use of working time of other operations against the situation preceding the improvements has not changed (the results have remained the same as in Table 5). Table 10 shows a suggested situation related to production following the introduction of improvements.

**Table 10.** Identification of bottlenecks in production line LP02 - suggested improvements

	Product B1	Product B2	Product B3	Product B4	Total
Forecast number of					
orders	70	110	60	100	340
Margin	100	200	150	75	-
OP04 [min]	280	440	240	500	1460

Source: own study

Despite introduced improvements, the constraint in operation OP04 is still present. However, attention should be drawn to the fact that the shortage of time to

fully execute orders dropped to 20 minutes (formerly it was 90 minutes). It allows us to conclude that we will be able to manufacture more products, which will result in higher revenues.

According to the theory of constraints, a step aiming at determining relative contribution margin should be repeated. In the case of products B2, B3 and B4, it will be the same as before (Table 6). In the case of product B1, the relative contribution margin indicator is:

$$RCM_{B1} = \frac{70}{4} = 25$$

Table 11 present current values of the RCM indicator after the improvements.

	Product B1	Product B2	Product B3	Product B4
Forecast number of				
orders	70	110	60	100
Margin	100	200	150	75
OP04 [min]	4	4	4	5
RCM	25	50	37.5	15

**Table 11.** Relative contribution margin for individual products - suggested improvements

Source: own study

Analysis of Table 11 allows concluding that the hierarchy of the profitability of individual products has not changed. B4 is still the least cost-effective product. To reduce the time spent on performing operation OP04, the time spent on manufacturing product B4 should be shortened by 20 minutes (1460-1440=20). According to Table 11, 500 minutes a day is still required to manufacture the entire order for product B4. Considering the need to decrease working time by 20 minutes, OP04 operation usage time should be reduced to 480 minutes. As Table 9 shows that the time of manufacturing one product B4 on operation OP04 is 5 minutes, with 480 minutes we may produce 96 pieces of B4 (480/5=96). In the present situation, the best solution will be:

- production of B2 in maximum order volume (110 pcs),

- production of B3 in maximum order volume (60 pcs),

- production of B1 in maximum order volume (70 pcs),

- production of B4 in the amount of 96 pcs.

The last step of the analysis of bottlenecks is to compare the result of revenues generated before and after introducing the improvement (Table 12).

Table 12. Comparison of revenues before and after improvements of production line
LP02

	Product B1	Product B2	Product B3	Product B4	Total
Before the improvement	7000	22000	9000	6150	44150
After the improvement	7000	22000	9000	7200	45200

Source: own study

The suggested improvement, aiming at shortening the time spent on performing operation OP04 by 1 minute, will cause the growth of revenues by PLN 1050 a day. On this basis it needs to be stated that the improvement is cost-effective, because the production system meets daily demand for products to a greater degree, and, consequently, generates higher revenues.

### 8. CONCLUSION

A bottleneck may be a reason for a number of unfavourable situations at a company, leading to significant financial losses. The entire production process should therefore be carefully monitored. It allows early identification of a bottleneck and reduction of its impact to a minimum level.

The theory of constraints focuses on increased throughput of a constraint, which, consequently, allows the increase in the throughput of the entire production system. Thus, the most important element of TOC is the throughput, i.e. the speed at which a company manufactures and sells its products and services, receiving cash in exchange. The practice of applying the theory of constraints shows that one's attention should be focused not on what should be limited, but on what should be increased. Thus, companies should absolutely concentrate on activities increasing throughput ("throughput thinking").

The authors of the article presented ways to identify bottlenecks and suggestions of various streamlining activities upon their identification in a production line manufacturing products of varied characteristics. The suggested solutions are chiefly of an organisational (costless) nature, according to the accepted criterion of choice. Future research will be directed to developing more detailed variants of calculations of relative contribution margin in the production system.

The solutions do not exclude the possibility to take advantage of other innovative options. The study may be an inspiration particularly for practitioners who apply the theory of constraints at their companies.

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# INFLUENCE OF TASK ENVIRONMENT ON EFFICIENCY OF MATERIAL FLOW IN COMPANIES WITH DIFFERENT LEVEL OF INTEGRATION OF PLANNING PROCESSES

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#### Abstract

Efficiency of processes determines the success of companies competing in contemporary market. The efficiency of production companies are heavily dependent on the efficiency of material flow. This is mostly due to high the cost-manufacturing processes. The efficiency of material flow depends on many factors. One of key factor is the task environment of company.

The authors focused their research around the integration of planning processes in companies. They noted that companies with integrated planning processes are less dependent to changes in the task environment. Continuing with this topic, authors have developed two models: model of integration planning processes in manufacturing companies and model of material flow.

The aim of the paper is to verify the following research hypothesis: the efficiency of material flow in companies with integrated planning process is less dependent on the volatility of the task environment.

The article presents the results of simulation conducted in the software iGrafx Process for SixSigma. In the simulation experiment reflects the volatility of the task environment and planning processes at different levels of integration. The conducted experiments allowed to collect the results on the efficiency of material flow. The authors measure the efficiency of material flow in many dimensions: as operational efficiency (measured by customer service level indicator) and financial (measured by profitability indicator).

The results were statistically analysed. Authors examined the correlation between the efficiency of material flow and the volatility of the task environment in conditions of different levels of integration of planning process. The research hypothesis was verified statistically with using an ANOVA method.

Key words: planning processes integration, task environment, material flow efficiency

### 1. INTRODUCTION

Globalisation is related to customers' increasing requirements and this causes that it is more difficult to maintain a competitive position. The competitive position maintenance is possible due to the efficiency improvement of operational processes. Not only the mere companies but also entire supply chains compete with each other at the market. Production companies in the supply chains conduct their operational activity combined with numerous procurement and sales partners. This causes a necessity to function in the conditions of high uncertainty and changing input data. The planning processes in production companies aim at decreasing the environment change influence (task environment in particular) on the material flow efficiency.

The aim of the paper is to present an influence of integration of planning processes on efficiency of material flow in companies in conditions of volatility of the task environment. Authors of the paper use ANOVA statistical method to verify hypothesis: the efficiency of material flow in companies with integrated planning process is less dependent on the volatility of the task environment.

# 2. THEORETICAL BACKGROUND

### 2.1. Integration of planning processes

Based on the concept valid in contemporary literature references it is possible to state that the process integration makes it feasible to enhance its efficiency (Cyplik et al., 2014, p. 4468; Danese et al., 2013, p.127; Hadas et al., 2015, p.228; Pagell, 2004, p.459; Seo et al., 2014, p.740). One of the possible planning process integration tools is sales and operations planning (SOP). There are many definitions of SOP. According to Muzumdar and Fontanella SOP is a set of business and technological processes that make it possible for a company to correlate the market demand with the manufacturing and procurement potential of the company in the possibly most efficient way (Muzumdar & Fontanella, 2007, p.36). The presented definition clearly indicates the SOP relationship with the company environment. The SOP influence on the efficiency of company (and material flow as an integral element of production companies) was indicated. The most complete SOP definition is presented in the APICS dictionary (Blackstone, 2010, p.123). In this book SOP is defined as a tactical planning tool that enables connection of customers' needs with the supply chain possibilities in the medium term. Such an SOP interpretation is perceived in numerous works. In their work Tuomikangas i Kaipia (2014, p.257) describe SOP as a key business tool that makes it possible to obtain balance between the customers' orders and the supply chain possibilities. The confirmation of these observations might be found in the publication (Collin & Lorenzin, 2006, p.424), in which their authors present a solution in which integrated planning influences an increase in the supply chain elasticity O'Leary-Kelly S.W. and Flores, B.E. (2002, p.238) performed research related to the integration level within decision-making processes by sales and production functions. According to the research results, the integration level increase influences the production enterprise efficiency improvement.

### 2.2. Task environment

Environment of the organization is generally defined as: all what is external to it, beyond its boundaries and what has influence on it. Due to Hatch (1994, p.54), organization's environment can be divided into two groups: general environment and task environment. In this paper only task environment will be considered. Organisation's task environment consists of the specific customers, suppliers, financiers and other entities with which it must interact to grow and survive (Castrogiovanni, 1991, p.557). The task environment may include a companies competitors, customers, suppliers, strategic partners and regulators (Scott & Lane, 2000, p.52). Task environment has a strong relations with companies and especially with its production-logistics system (Adamczak et al. 2016, p.670). The environment changeability (and task environment in particular) is largely implied by the globalisation phenomenon and economy networking (Castells, 2009, p.17).

A chaos in the environment is caused by strong dependencies between entities located in various globe parts. Lorenz (1963, p.137) described the chaos behaviour mechanisms for the sake of management named it as a "butterfly effect " that relies on making large changes by seemingly trifling causes.

# **3. RESEARCH MODEL**

One might distinguish three fundamental parts in the developed research model:

- model of the planning process integration in production enterprises,
- model of operational processes executed by production enterprises,
- model of task environment.

The most significant element of the developed research model is the model of integrating planning processes in production enterprises. The model was formed based on the results of literature research and the empirical research performed among 149 production enterprises in the territory of Poland. A detailed description of the results of the research on the planning process integration in the active production enterprises in the territory of Poland et al. (2013, pp.12-59). Table 1 includes a qualitative description of the planning process integration levels which is developed for the sake of the research model.

Planning process integration level	Characteristics of level
D	No planning process integration, production plan developed adaptively to the sales plan, available resources at a constant level in the process duration based on standards specified in the past, no financial plan and marketing actions included in the plan.

Table 1. Description of planning process integration level	ration levels	process integ	of planning	ption of	1. Descri	Table
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С	Corrective procedures implemented in the area of the sales and production planning and in the area of production and
	procurement. The objective of the procedures is to select the
	most appropriate solution to executing the proposed sales plan
	in terms of the planned profit and return on sales by the
	financial plan simulation, available resources specified at a
	constant level in the process duration based on standards
	specified in the past, no marketing actions included in the plan.
В	Corrective actions as at level C with the financial plan,
	available resources specified based on real data about repairs
	and/or developing the resources as a result of the conducted
	investment actions, no marketing actions included in the plan.
А	All the actions conducted as at level B without the marketing
	plan. At integration level A the marketing plan is formed based
	on real data (plan promotional campaigns, extending and
	enlarging market areas, product portfolios, etc.). The plan is
	included in the planning process structures and therefore
	influences the material flow plan which is under construction.

Source: own study

In model of operational processes executed by production company one modelled basic material flow processes in production company. In this regard one used the SCOR supply chain referential model in version 12 (material flow was modeled with use of 5 types of processes: plan, source, make, deliver, return). The material flow processes are planned according to the procedures which were developed based on the defined planning process integration levels (table 1). The material flow performance lasts one year (material flow on every work day, planning processes once a month).

In model of task environment 3 factors were distinguished. Each of the factors is related to demand. In the planning model one specifies the demand as forecasted for each of 12 months included in the plan. The forecast for consecutive months is implied by 3 parameters: constant quantity (adopted in the model and referred to the capacity of production system) seasonality of demand and trend of demand.

The seasonality of demand was modelled in two steps. In the first step one specified a seasonality strength (Ss) was calculated according to the formula:

$$Ss = \frac{D_{S_{m_{max}}} - \overline{D}}{\overline{D}}$$

where:

 $D_{Sm_{max}}$  – sales forecast in the month with the highest sales volume  $\overline{D}$  – average forecast for the entire year

Seasonality strength (Ss) was specified as simulation scenario parameter and underwent changes in the consecutive simulations. In the next step one modelled the seasonality phenomenon throughout the entire year according to the formula:

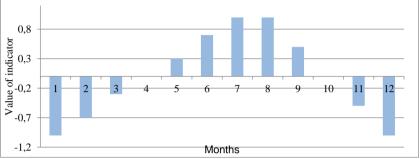
$$D_{S_m} = Ss \cdot Sc_m$$

where:

 $D_{S_m}$ - additional demand caused by seasonality of the demand  $Sc_m$ - seasonality coefficient to m-month

The monthly coefficient values of the seasonality strength are presented in Figure 1.

Figure 1. Values of monthly coefficients for the seasonality strength



Source: own study

In order to keep the conditions (equal demand sum) unchanged in the case of all experiments independent of the seasonality strength the sum of the values of the coefficients for the entire year equals 0.

The trend of demand and the seasonality of demand were modelled at 2 stages. At the first stage one specified the trend strength (Ts) was calculated according to the formula:

$$Ts = \frac{D_{T_{ml}} - \overline{D}}{\overline{D}}$$

where:

 $D_{T_{ml}}$  – last-month sales forecast (in the planning horizon)  $\overline{D}$  – average forecast for the entire year

Trend strength (Ts) was specified as a simulation scenario parameter and underwent changes in the consecutive simulations. At the next stage one modelled the demand trend phenomenon throughout the entire year according to the formula:

$$D_{T_m} = Ts \cdot Tc_m$$

where:

 $D_{T_m}$ - additional demand caused by trend of the demand  $Tc_m$ - trend coefficient to m-month

The monthly coefficient values of the seasonality strength are presented in Figure 2.

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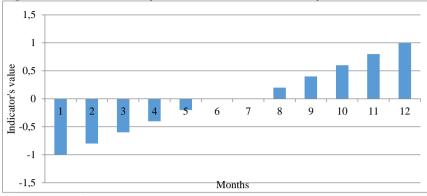


Figure 2. Values of monthly coefficients for the seasonality trend

Source: own study

In order to keep the conditions (equal demand sum) unchanged in the case of all experiments independent of the trend strength the sum of the values of the coefficients for the entire year equals 0.

The real demand, which will appear this month, is implied by the forecasted demand (calculated based on the parameters as described above) and the forecasting error. The real monthly demand (laid out to consecutive work days of the month) is specified by means of normal distribution (authors assume that simulation was conducted in the terms of MTS model - to fast rotation items). The distribution parameters are: monthly (average) forecast, monthly forecast multiplied by the demand fluctuations (standard deviation) parameter. The demand fluctuations were specified as a simulation scenario parameter and underwent changes in the consecutive simulations. It is required by the drawing in accordance with the normal distribution to perform simulations in numerous iterations.

Each of the 3 scenario parameters, which determined the task environment changeability, occurred in the simulation experiment in 3 states: 1-L - low changeability, 2-M - medium changeability, 3-H - high changeability. In table 2 there are numerical values of the parameters that correspond to each of the defined states:

<u>``</u>	environment					
	State of task	Demand	Trend of	Seasonality of		
	environment factor	fluctuation	demand	demand		
	1-L	0.10	0.00	0.00		
ſ	2-M	0.20	0.15	0.15		
ſ	3-Н	0.30	0.30	0.30		

**Table 2.** Values of changeability parameters in the case of selected factors of task

 environment

Source: own study

Efficiency of a material flow in manufacturing company will in this article be interpreted as a sum of two factors (Clermont, 2016, p.1358; Frankowska & Jedliński, 2011, p.78):

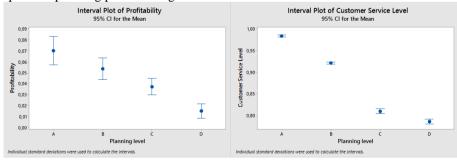
- effectiveness of action ability to achieve set goals;
- efficiency of action an optimal use of owned resources (may be related to the rationality of management, economy or profitability).

Two factors presented above could be treated as a special economic efficiency cases. The economic efficiency might be specified as a result of a business entity's activity. It is a result of the relation between the obtained effects and the borne costs (Farrell, 1957, p.268). The most frequently used economic efficiency measures are: logistic cost level, general cost level, profit and sales profitability. The measures might be found in the work by Hahn and Kuhn (2011, p.518). The operational efficiency is most frequently expressed by means of such measures as customer service level, delivery time, prognosis accuracy, inventory level. These measures were applied by Kolinski and Śliwczynski (2015a, p.215), Kolinski and Śliwczynski (2015b, p.178); Koliński el al. (2016, p.135) and Sodhi and Tang (2011, p.529).

# 4. ANALYSIS OF RESULTS

4 factors are considered in the simulation experiment. According to the presented model the factors could occur in 3 states (3 factors reflecting the task environment changeability) and 4 states (factor reflecting the planning process integration level). The simulation was performed in 10 iterations due to the necessity to eliminate the random factor influence within the simulation results. Thereby, 1080 ( $3^3 \cdot 4 \cdot 10$ ) simulations were performed in the experiment. According to the adopted efficiency interpretation (chapter 3) the following measure values were analysed: profitability and customer service level. More details about simulation model are described in one of the previous paper of the authors (Adamczak et al. 2014).

In the first place it was checked whether the model reflected the adopted solution: the higher planning process integration level causes an increase in the material flow efficiency. The indicator values in the case of particular planning process integration levels are presented in Figure 3.



**Figure 3.** Profitability and customer service level indicator values in the case of the specified planning process integration levels

Source: own study

The planning process integration has a positive impact on the material flow efficiency indicator values. As implied by the charts presented in Figure 3, the profitability and customer service level indicator values are higher in the case of higher planning process integration levels (value of indicators: profitability and customer service level is the highest in conditions of A level of integration of planning processes). Once the model assumptions were confirmed by the result analysis the authors moved on to the stage of verifying the research hypothesis: the efficiency of material flow in companies with integrated planning process is less dependent on the volatility of the task environment This hypothesis verification was performed by means of 2 methods: the quotient and regression one.

In the quotient method the obtained results were divided into 4 subsets that reflected each of the planning process integration levels. As to each subset and each parameter reflecting the task environment changeability, one calculated a ratio of the indicator values in 2 consecutive parameter states. The ratio calculation formula is as follows:

$$quot. = \frac{value_{ls} - value_{hs}}{|value_{ls}|}$$

where

 $\mathsf{value}_{\mathsf{ls}}$  -indicator value with the lower state of the parameter reflecting the task environment changeability

 $\mathsf{value}_{\mathsf{hs}}$  -indicator value with the higher state of the parameter reflecting the task environment changeability

The values of ratios at each planning integration level are presented in tables 3-6.

Parameter	Seasonalit	y of demand	Trend of demand		Demand fluctuations	
state	Prof.	CSL	Prof.	CSL	Prof.	CSL
L-M	1.7668	0.0000	0.8480	0.0098	-0.3122	-0.0020
M-H	2.5551	0.0000	1.6819	0.0277	-0.2249	0.0036
Average	2.1609	0.0000	1.2650	0.0187	-0.2686	0.0008

**Table 3.** Coefficient value quotients in the case of neighbouring task environment parameter states at planning process integration level A

Source: own study

**Table 4.** Coefficient value quotients in the case of neighbouring task environment

 parameter states at planning process integration level B

Parameter	rameter Seasonality of demand		Trend of demand		Demand	
state	2	ucmanu	fluctuations			
state	Prof.	CSL	Prof.	CSL	Prof.	CSL
L-M	0.9973	0.0000	0.7571	0.0077	0.1620	0.0015
M-H	2.6319	0.0001	2.3463	0.0145	0.2474	0.0098
Average	1.8146	0.0001	1.5517	0.0111	0.2047	0.0056

Source: own study

Parameter		nality of mand	Trend of demand		Demand fluctuations	
state	Prof.	CSL	Prof.	CSL	Prof.	CSL
L-M	0.0035	0.0000	1.4305	0.0649	-0.0930	0.0138
M-H	49.7739	0.0004	2.7560	0.0670	-0.2997	0.0087
Average	24.8887	0.0002	2.0932	0.0660	-0.1964	0.0113

**Table 5.** Coefficient value quotients in the case of neighbouring task environment parameter states at planning process integration level C

Source: own study

**Table 6.** Coefficient value quotients in the case of neighbouring task environment

 parameter states at planning process integration level D

Parameter	Seaso	Seasonality of		Trend of demand		Demand	
state	der	nand	Tiend of defin		fluctuatio		
state	Prof.	CSL	Prof.	CSL	Prof.	CSL	
L-M	0.0046	0.0000	3.0078	0.0568	0.8191	0.0186	
M-H	4.3232	0.0402	1.4352	0.0583	3.1727	0.0290	
Average	2.1639	0.0201	2.2215	0.0575	1.9959	0.0238	

Source: own study

In order to simplify the presentation one calculated average quotient values in the case of particular process integration levels. The analysis results are presented in table 7.

**Table 7.** Average values of the indicator value quotients in the case of neighbouring task environment parameter states at all planning process integration levels

Planning level	Profitability	Customer service level
А	1.0524	0.0065
В	1.1903	0.0056
С	8.9285	0.0258
D	2.1271	0.0338

Source: own study

The average values of the quotients presented in table 7 tend to be increasing. This is accompanied by the decrease in the planning process integration level. There are two exceptions from this rule: quotients of the profitability indicator at planning process integration level C and the customer service level indicator at planning process integration level B. The quotient values show the task environment changeability influence on the material flow efficiency in production companies. The smaller the difference between the values of the efficiency indicators, the smaller the task environment changeability influence on the material flow efficiency. To make a conclusion based on the results in table 7 it might be (although ambiguously) stated that the efficiency of material flow in companies with integrated planning process is

less dependent on the volatility of the task environment – therefore, the formulated hypothesis is positively verified.

The second research hypothesis verification method is based on specifying regression equations in the case of sets of task environment parameter values and indicator values at particular planning process integration levels. To simplify the interpretation, the research was confined to linear regression equations. In the case of such an assumption the task environment changeability influence will be specified by the value of the regression line slope. Before one began the regression analysis it had been checked by means of the ANOVA method whether the indicator values in the case of various task environment changeability states were statistically significantly different from each other. In the ANOVA method one formulated a pair of statistical equation hypotheses in the case of each indicator and each task environment factor:  $H_0$ : The indicator values in the case of all the task environment factors are not different from each other.

 $H_1$ : The indicator values in the case of all the task environment factors are different from each other.

The analysis was performed on the assumption that significance level  $\alpha$ =0.01 The p-value in the case of the consecutive ANOVA-verified pairs of hypotheses were presented in table 8.

Task environment factor	Profitability	Customer service level
Demand fluctuation	0.984	0.039
Trend of demand	<0.001	< 0.001
Seasonality of demand	< 0.001	0.412

Table 8. p-value values obtained in the ANOVA method

Source: own study

According to the adopted assumption related to the significance level values there is no need to withdraw the null hypothesis in the cases. The null hypothesis is about no differences between the efficiency indicator values (the p-value value in those cases is higher than the adopted significance level). This means that the profitability indicator value will not get statistically significantly changed if the demand fluctuation parameter values are changed. As regards to the customer service level indicator, the profitability value will not get changed if the factors of demand fluctuation and seasonality of demand are changed. Due to the above these cases will be excluded from further regression analysis. As regards to the remaining 3 cases, one performed the regression analysis. It was supposed to specify the linear regression equations for the relationship between the efficiency indicator value and the task environment changeability parameter value in the case of each of the planning process integration levels. The regression function formulas are presented in tables 9 and 10.

Planning level	Regresion line	$\mathbb{R}^2$					
	Trend of demand						
А	0.1185 – 0.3218 Trend of demand	13.6%					
В	0.09212 – 0.2562 Trend of demand	13.9%					
С	0.09648 – 0.3932 Trend of demand	59.9%					
D	D 0.06829 – 0.3539 Trend of demand						
	Seasonality of demand						
А	0.1853 – 0.7670 Seasonality of demand	77.0%					
В	0.1418 – 0.5877 Seasonality of demand	73.0%					
С	C 0.06654 – 0.1936 Seasonality of demand						
D	0.03269 – 0.1166 Seasonality of demand	6.9%					

Table 9. Regression function formulas in the case of the profitability indicator

Source: own study

**Table 10.** Regression function formulas in the case of the customer service level

 indicator

Planning level	Planning level Regresion line				
	Trend of demand				
А	1.002 – 0.1211 Trend of demand	48.9%			
В	0.9317 – 0.06782 Trend of demand	19.7%			
С	0.8617 – 0.3445 Trend of demand	82.0%			
D	D 0.8298 – 0.2929 Trend of demand				

Source: own study

It was assumed in the analysis that the smaller the slope value means a smaller influence of a given factor on the efficiency indicator value. Thereby, one should expect smaller values (absolute values) of the slope in the conditions of higher planning process integration levels. As implied by the regression function formulas in tables 9 and 10 such an unambiguous situation exists in no case. The situation relies on reflecting the proposed trend of changes in the case of all the planning process integration levels. However, one might find certain regularities. The profitability indicator level is less dependent on the trend of demand parameter values at higher integration levels (A and B) than at the lower ones (C and D). Similarly, the customer service level indicator value is less dependent on the trend of demand with the higher planning process integration levels than with the lower ones. The dependency of the profitability indicator value on the seasonality of demand is exact the opposite. The value of the both indicators is higher in the case of higher planning process integration levels. The divergent values of the coefficient of determination make it more difficult to interpret the results. If this indicator value goes under 0.6, the interpretation might be significantly flawed. In the authors' view it is therefore impossible to verify the research hypothesis as it depends on the above presented results.

# 5. CONCLUSION

One of the key tasks of planning processes in production companies is to make the material flow efficiency independent of the task environment changeability. In the article the authors searched for an answer to the question about whether the above objective is possible to be achieved by means by the authors' own planning process integration model (with respect to both the contents – integrated plans and process– integrated plan development). The formulated research hypothesis: the efficiency of material flow in companies with integrated planning process is less dependent on the volatility of the task environment was verified by means of 2 methods: quotient and regression.

In the quotient method one analysed the differences in the efficiency indicator values between the consecutive parameter states. They reflected the task environment changeability in the conditions that corresponded to various planning process integration levels. One averaged the results from various environment-changing factors. The focus was merely put on average values of the measure quotient values of efficiency indicators in the case of particular planning process integration levels. The analysis conducted by this method made it possible to positively verify the forumlated research hypothesis.

In the regression method the focus was put on analysing the dependencies between the efficiency indicator values on the changeability of the task environment parameter values (separately in the case of each task environment changebaility parameter). The analysis conducted by this method did not make it possible to unambigously verify the forumlated research hypothesis.

To conclude the above considerations one should notice that the planning process integration in accordance with the presented model makes it feasible to make the material flow efficiency independent of the task environment changeability. However, it is impossible to indicate what integration influence is on the material flow independence on particular task environment changeability aspects (demand fluctuation trend of demand, seasonality of demand). The conducted experimental research does not make it feasible to prove the relationships of particular factors of the changing task environment. While defining the next research objectives, one should increase the number of factors that would describe the task environment changeability and extend the number of states in which the factors might occur. Such an action would enable obtainment of an even larger result database. As a consequence, the results would be more profoundly analysed.

# 6. ACKNOWLEDGEMENT

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# OPERATIONAL CONTROLLING IN THE MANAGEMENT OF SPARE PARTS AVAILABILITY

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### Abstract

In order to meet the aimed financial result and market competitiveness, the management of a manufacturing enterprise's operating system and supply chain requires a system connection and the use of many tools, among others, financial and operational analysis, value management of processes and development of business models of cooperation with partners in the supply chain. Controlling assists resultoriented management and creates a subfunctional management system which supports management personnel in making decisions and creating mechanisms of efficient and effective management. The aim of the article is to determine the scope of use of the operating controlling system and its impact on the management of the availability of spare parts and the effectiveness of the production process. The article presents a system of indicators for assessing the efficiency of spare parts management in their supply chain as well as the results of empirical verification of the controlling system. The results of the research carried out by the Authors indicate that the process of maintenance and the availability of spare parts, especially in highly machinized, robotized and automatized production processes, is one of the most important factors in their continuity, failure recovery rate, and repair performance rate.

Keywords: operational controlling system, spare parts availability, production process efficiency

# **1. INTRODUCTION**

In reference books on the continuity of production process, the authors revolve around research and analyses of production flow processes as production product and management of stock of finished goods, semi-finished products or raw materials. The issue of the availability of spare parts that safeguards the continuity of production resources is rarely addressed. The research results indicate that the process of maintenance and spare parts availability, especially in highly machinized, robotized and automatized production processes, is one of the most important factors in their continuity, failure recovery rate, and repair performance rate.

Numerous discussions on maintenance and service issues can be found in the reference books. According to ISO/TS 16949:2002 standard, the organization identifies the key equipment to run the process, provides resources for machine/ equipment maintenance and develops the effective planned system of full preventive maintenance. It is required that the system of operations of maintenance services includes (ISO/TS 16949:2002(E), p. 34):

- planned maintenance activities,
- packaging and protection of equipment, instrumentation and measuring devices,
- availability of spare parts for key production equipment,
- documenting, evaluating and improving service objectives.

With the development of scientific and technical knowledge and the complexity of machinery and equipment construction, as well as their electronization, automation and mechanization, there is a noticeable increase in the impact of faulty equipment on the maintenance of the continuity of the production process and the development of maintenance systems for equipment and machinery. The classic approach to managing maintenance in a production environment highlights the importance of inspections, maintenance, and repairs, while the new approach to maintenance focuses on the following issues (Legutko, 2009, p. 9-10):

- decision support tools: risk assessment, damage intensity models and analysis of their effects and expert systems,
- new maintenance techniques, e.g. state monitoring,
- changes in thinking about maintenance organization leading to joint participation and teamwork.

Therefore, it can be said that the development of the controlling system for spare parts availability management is a tool for supporting maintenance decisions, and in a broader process perspective, that it influences the effectiveness of the production process.

# 2. OPERATIONAL CONTROLLING IN ENSURING THE CONTINUITY OF MATERIAL FLOW

According to P. Drucker, the most important features of an enterprise management system include permanent and comprehensive monitoring and improving the efficiency of processes, focused on the basic and most important result, i.e. a client satisfied with the delivered product (Drucker, 2012). A system of strongly related factors of the operation of an enterprise – clients, products, processes, and resources – forms the scope and range of operational management (Christopher, Juttner & Godsel, 2006; Lambert, Knemeyer, Gardne, 2009; Waters, 2002). The results of long-term research (Śliwczyński, 2011; Franz, Kirchmer, 2012) on the adaptation of the enterprise management system to the changing market environment

conditions point to a shift in the weight of the enterprise management towards the Score-Driven Management (SDM) model and the Value-Driven Business Process Management (VD BPM) model. Controlling is a tool that supports effective enterprise management in the conditions of a dynamically changing market. Logistics processes oriented towards ensuring material flow continuity in the supply chain are one of the key areas for applying operational controlling in an enterprise.

Controlling is a system that assists the management of an organization in achieving objectives (Fig. 1) by coordinating the processes of planning, organization, management and steering, controlling, as well as collecting and processing information (Sliwczynski, Kolinski, 2016).

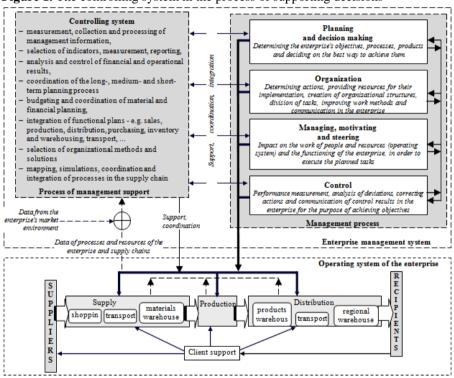


Figure 1. The controlling system in the process of supporting decisions

Source: own study (Sliwczynski, Kolinski, 2016)

Controlling integrates and coordinates the following in an enterprise (Fig. 1):

- management functions planning, organization, management and steering, control, response, and correction,
- activity areas sales, distribution, manufacturing, purchasing and supply, marketing, research and development, customer service, warehousing and inventory, transportation, human resources management, outsourcing,

- management levels and stages of developing management decisions (strategic, tactical and operative) in the long, medium and short-term,
- value chains integrating the needs of the market and the customer, products, processes and resources, as well as business performance (financial and operational), affecting the improvement of efficiency and eliminating waste (including bottlenecks).

The resulting management of information supports the decisions of selecting the methods and parameters of managing operations and resources in individual material flow phases, shaping the achieved results and value chain. Integration of all these elements is necessary to improve efficiency of logistics process. Integration is one of the most important of management style (Turkalj, Fosic, Dujak, 2008) and is successful tool in business practice.

Operational controlling is a system that assists operational management in achieving goals through the integration and coordination of planning, organization, steering, and control, as well as the collection and processing of information in relation to the product, processes and resources in the full supply chain (Śliwczyński, 2011).

The processes and resources shaped by controlling in the material flow are the result of the values of goals set for a manufacturing enterprise, its potential (production capacity), and the demands of (internal and external) clients, suppliers and subcontractors. Determining the methods of process management (e.g. purchasing and supplies, warehousing, transportation of spare parts) takes place already at the planning stage of operational measures and material flows in the supply chain. Continuous feedback taking into account the uncertain and variable demand for spare parts in production is the basis for correcting the plans, norms, methods, and parameters of process steering, resource allocation, designing of procedures and organizational structures, and budgets (material and financial plans). For this reason, the Authors focused their scientific research on the further development of an analysis of spare parts availability management within the controlling aspect.

# **3. MANAGEMENT OF SPARE PARTS AVAILABILITY WITHIN THE CONTROLLING ASPECT**

The primary source of information needed to perform the controlling analysis of the management of spare parts availability is the linkage of the operating data associated with the flow of materials and the corresponding cost data recorded in the corporate chart of accounts. Data from the financial and accounting system make it possible to designate the economic indicators and measures within the scope of the spare parts availability model assessment system.

Based on the analysis of reference books (Pfohl, 2016; Sliwczynski, Kolinski, 2016; Twarog, 2003), a set of measures was determined, which was the basis for calculating the indicators for a controlling assessment of spare parts availability management.

Category	Indicator	Formula	Characteristics
	costs of transport of a spare part from the supplier to the place of repair	$K_{T_{DN}} = l_d \cdot l_{km} \cdot k_{km}$ $\cdot l_{ST}$ $+ l_d \cdot k_e$	$\begin{array}{ll} l_{d} - number \mbox{ of deliveries in a given period} \\ between the supplier and the place of repair \\ l_{km} - number of kilometers traveled by individual means of transport on the supplier-place of repair route in a given period \\ k_{km} - cost of 1 kilometer for an individual means of transport on the supplier-place of repair route \\ l_{ST} - number of individual means of transport used on the supplier-place of repair route in a given period \\ k_{e} - cost of operation of the used means of transport on the supplier-place of repair route in a given period \\ k_{e} - cost of operation of the used means of transport on the supplier-place of repair route in a given period \\ k_{e} - cost of operation of the used means of transport on the supplier-place of repair route in a given period \\ \end{array}$
Transport	costs of transport of a spare part from the supplier to the warehouse in a given period	$K_{T_{DM}} = l_d \cdot l_{km} \cdot k_{km} \\ \cdot l_{ST} \\ + l_d \cdot k_e$	$\begin{split} & l_{d} - \text{number of deliveries between the supplier and the warehouse in a given period \\ & l_{km} - \text{number of kilometers traveled by individual means of transport on the supplier-warehouse route in the given period \\ & k_{km} - \text{cost of 1 kilometer for an individual means of transport on the supplier-warehouse route \\ & l_{ST} - \text{number of individual means of transport used on the supplier-warehouse route in a given period \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route in a given period \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route in a given period \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route in a given period \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e} - \text{cost of operation of the used means of transport on the supplier-warehouse route } \\ & k_{e$
	costs of transport of a spare part from the warehouse to the place of repair in a given period	$K_{T_{MN}} = l_d \cdot l_{km} \cdot k_{km} \\ \cdot l_{ST} \\ + l_d \cdot k_e$	$\begin{split} & l_{d} - \text{number of deliveries between the} \\ & warehouse and the place of repair in a given period, \\ & l_{km} - \text{number of kilometers traveled by the} \\ & \text{individual means of transport on the} \\ & warehouse-place of repair route in a given period, \\ & k_{km} - \text{cost of 1 kilometer for an individual} \\ & \text{means of transport on the warehouse-place of repair route,} \\ & l_{ST} - \text{number of individual means of} \\ & \text{transport used on the warehouse-place of} \\ & \text{repair route in a given period,} \\ & k_{e} - \text{cost of operation of the used means of} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & k_{e} - \text{cost of operation of the used means of} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & k_{e} - \text{cost of operation of the used means of} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & k_{e} - \text{cost of operation of the used means of} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & \text{transport on the warehouse-place of repair route in a given period,} \\ & transport on the warehouse-place of r$

**Table 1.** Set of indicators for a controlling assessment of spare parts availability

 management

Operational controlling in the management of spare parts availability

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costs of maintenance of spare		$\mu$ – cost factor of maintenance of spare
	$K_{UT} = \mu \cdot Z \cdot c$	parts in stock,
parts in stock		Z – average volume of spare parts stock in a given period
costs of acceptance	$K_{\rm p} = l_{\rm p} \cdot k_{\rm p}$	$l_p - number \ of \ acceptances \ of \ spare \ parts \\ in \ a \ given \ period$
of a spare part	mp vp njp	$k_{jp}$ – unit cost of acceptance of a spare part
cost of a spare part storage in the	$K_{SK} = Z_{CZ} \cdot k_{jSK}$	$\begin{array}{l} Z_{cz}-\text{size of spare part stock according to} \\ \text{the accepted storage units (e.g. pallet} \\ \text{places, m2, m3, etc.)} \\ K_{jSK}-\text{unit cost according to the accepted} \end{array}$
warehouse		storage unit
costs of completion	$K_{\mu} = l_{\mu} \cdot k_{\mu}$	$l_{\rm K}$ – number of completed spare parts in a given period,
of a spare part	$K_K = t_K - t_{jK}$	$k_{jK}-unitcostofcompletionofa$ spare part
costs of release of a	$K_W = l_W \cdot k_{iW}$	$l_{\rm W}-$ number of releases of spare parts in a given period,
spare part	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	$k_{jW}-\text{unit cost of release of a spare part}$
costs of placing an		$\label{eq:k_jzcz} k_{jzcz} - \text{cost of one order associated with} \\ \text{the purchase of a spare part}$
order for a spare part at the supplier's	$K_{Z_{CZ}} = k_{jZ_{CZ}} \cdot l_{Z_{CZ}}$	$l_{ZCZ}$ – number of placed orders for the purchase of a spare part in a given period
costs of placing an		$k_{jZU}$ – cost of one order associated with the purchase of a repair service,
order for a repair service at the supplier's	$K_{Z_U} = k_{jZ_U} \cdot l_{Z_U}$	$l_{\rm ZU}$ – number of placed orders for the purchase of repair services in a given period
costs of placing an order for a		$k_{jZCZ-U}$ – cost of one order associated with the purchase of a spare part and a repair service,
spare part and a repair service at the	$K_{Z_{CZ-U}} = k_{jZ_{CZ-U}} \cdot l_{Z_{CZ-U}}$	$l_{ZCZ-U}$ – number of placed orders for the purchase of spare parts and repair services in a given period
s	stock costs of acceptance of a spare part cost of a spare part storage in the warehouse costs of completion of a spare part costs of release of a spare part costs of placing an order for a spare part at the supplier's costs of placing an order for a repair ervice at the supplier's costs of placing an order for a repair	stockcosts of acceptance of a spare part $K_P = l_P \cdot k_{jP}$ cost of a spare part storage in the warehouse $K_{SK} = Z_{CZ} \cdot k_{jSK}$ cost of a spare part $K_{SK} = Z_{CZ} \cdot k_{jSK}$ costs of completion of a spare part $K_K = l_K \cdot k_{jK}$ costs of release of a spare part $K_K = l_W \cdot k_{jW}$ costs of placing an order for a repair $K_{ZCZ} = k_{jZCZ} \cdot l_{ZCZ}$ k supplier's $K_{ZU} = k_{jZU} \cdot l_{ZU}$ costs of placing an order for a repair $K_{ZU} = k_{jZU} \cdot l_{ZU}$ k supplier's $K_{ZCZ-U} = k_{jZCZ-U} \cdot l_{ZCZ-U}$

Source: own study

In the case of transport organization by the supplier, this cost is determined by the supplier, whereas in the case of transport organization by an enterprise this cost is determined by:

- external company if an enterprise subcontracts such a service, then the cost is determined by this company,
- enterprise if the enterprise carries out the transport with its own rolling stock. In such a case, the cost components include: the number of kilometers to be traveled by a particular means of transport, the cost per 1 kilometer for a particular means of transport, the cost of operation of the used means of transport, the number of a particular means of transport, the number of deliveries.

An independent element of the spare parts availability management model is efficiency analysis. Efficiency analysis, based on the selected indicators, is becoming an increasingly popular area of analyses, related to financial results and used in enterprises. The research co-conducted within the operation of the Institute of Logistics and Warehousing in Poznan shows not only an increasing interest in analyses of the efficiency indicators of logistics processes but also the effectiveness of decisions made on their basis, as evidenced by the positive changes of indicator values in the annual observations<sup>1</sup>. Based on the analysis of the reference books (Hajdul, Kolinska, 2014; Kolinski, Sliwczynski, Golinska-Dawson, 2016; Krzyzaniak, 2015; Muchiri et al, 2011; Parida et al., 2015; Turkalj, Fosic, Dujak, 2010; Tsang, Jardine, Kolodny, 1999; Twarog, 2005; Stajniak, Kolinski, 2016) and conceptual works in research projects, <sup>2,3,4</sup> a set of indicators and measures was determined, which is presented in Table 2.

**Table 2.** Set of indicators and measures for the assessment of efficiency of spare

 parts availability management

Category	Indicator	Formula	Characteristics	Measure unit
Transport	supply reactivity index	$W_{RD} = \frac{l_{cZPT}}{l_{cZ}}$	$l_{czPT}$ – number of spare parts delivered before deadline within the analyzed period, $l_{cz}$ – number of spare parts delivered within the analyzed period	%
Ţ	index of transportation demand	$W_{TR} = \frac{T_{TR}}{l_d}$	$T_{TR}$ – transportation time within the analyzed period, $l_d$ – number of deliveries within the analyzed period	h/delivery
Stock management	coverage index	$W_P = \frac{Z}{W_Z} \cdot l_{dni}$	Z – average volume/value of the spare parts stock in the analyzed period, $W_Z$ – volume/value of the consumption of spare parts in the analyzed period, $I_{dni}$ – number of days within the analyzed period	days
01	index of share of not rotating		$Z_{NR}$ – value of not rotating spare parts stock,	%

<sup>&</sup>lt;sup>1</sup> In the years 2008-2012, an analysis was conducted on the use of indicators at the global level. As of the second half of 2013, the analysis of the use of individual indicators and their impact on decisions was conducted using the Internet platform. The use of the Internet platform aimed to identify the trends of the indicators' changes, taking into account the specificity of individual industries and the possibility to compare individual values of indicators on benchmarking principles (Kolińska, Cudziło, 2014, p. 21-32). <sup>2</sup> Development of a prototype of the Electronic Logistic Platform for handling enterprises using the 4PL/5PL concept, Institute of Logistics and Warehousing, Poznan 2007-2010.

<sup>&</sup>lt;sup>3</sup> Simulation of managing the flow of a company's material as an instrument of multivariant analysis of transport processes efficiency no. N N509 549940, Poznań School of Logistics, Poznan 2011-2013.

<sup>&</sup>lt;sup>4</sup> Development of methods and tools (including IT applications) supporting the analysis and improvement of enterprise logistics processes and supply chains – Platform development – benchmarking of indicators (LOGIBAR Platform), S-3737-4-2014, Institute of Logistics and Warehousing, Poznan 2014.

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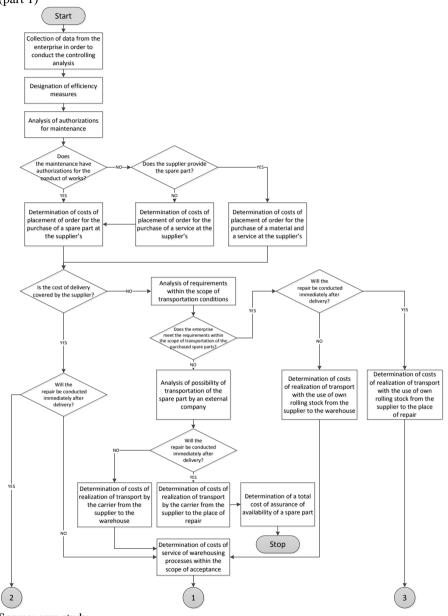
	stock in the stock	$W_{NR} = \frac{Z}{W_Z}$	$Z_{W}$ – total value of spare parts stock	
ousing	warehouse employee work efficiency index	$W_{WM} = \frac{W_O}{l_{PR}}$	$W_0$ – volume of turnover of spare parts stored within the analyzed period, $l_{PR}$ – number of employees in the warehouse within the analyzed period	unit/person
Warehousing	index of labor intensity of the stored spare parts releases	$W_{PWM} = \frac{l_G}{W_W}$	l <sub>G</sub> – number of warehouse employee's working hours within the analyzed period W <sub>w</sub> – volume/value of stored spare parts releases within the analyzed period	-
Purchases	index of timeliness of deliveries	$W_{TD} = \frac{l_{dt}}{l_d}$	$l_{dt}$ – number of deliveries completed on time within the given period, $l_d$ – number of deliveries in the given period	%
Purch	balance of completed orders	$W_{RZ} = \frac{C_d}{C_z}$	$C_d$ – number of items of the given spare part delivered by the suppliers in the given period, $C_z$ – number of spare part items ordered within this period	%

Source: own study

This division has been developed analogically to the concept of the cost analysis of spare parts availability. In order to be able to compare the two elements of the model of spare parts availability management, it was decided to divide the indexes and measures of efficiency of activities associated with the assurance of production process continuity in terms of processes having a direct impact on production continuity (transport, storage, stock management, purchases).

Taking into account the defined set of indexes and measures, the procedure algorithm (Fig. 2 and Fig. 3) has been developed, which enables to determine the costs incurred to ensure the availability of spare parts and the index-based assessment of spare parts availability assurance within the controlling aspect.

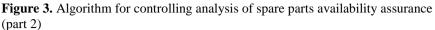
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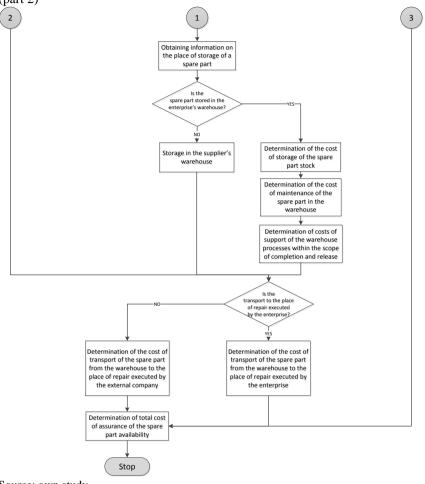


**Figure 2.** Algorithm for controlling analysis of spare parts availability assurance (part 1)

Source: own study

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Source: own study

The total costs of spare parts availability assurance is the sum of costs of stock consumption incurred due to the implementation of this process. Depending on the course of this process, the elements making up the total costs of spare parts availability assurance vary.

# 4. METHODOLOGY OF EMPIRICAL VERIFICATION

Empirical verification is a process of determination of the extent to which the model faithfully reflects the actual system from the assumed point of view (Sargent, 2001). This aims at determining whether the simulation of the production environment provides reliable results, to the assumed extent in line with the responses of the actual system to identical input data. Thanks to verification, the model designer obtains

information on its compliance with the assumptions adopted in the modeling process, and the validation based on the simulation of actual conditions verifies the compliance of the model operation according to the adopted assumptions in the actual conditions of the production process.

The analysis of the literature concerning the research methodology indicates that the research methods using the case study are not subject to evaluation of the test sample representativeness (Siggelkow, 2007, p. 21). Depending on the purpose of the conducted scientific research, the discussed method may take the form of an individual or multiplied case study. The individual case studies are aimed at confirming the theoretical assumptions, while the multiplied case studies enable to test the theory by comparing the cases with oneanother (Barratt et al., 2011, pp. 235-236). The multiplied case study is based on the selection of different or similar cases which aim at providing different or similar results respectively (Yin, 2009, p. 54).

When performing the analysis of the literature on the subject, one can find various opinions on the number of the conducted case study variants (Eisenhardt, Grabner, 2007, p. 27; Ketokivi, Choi, 2014, pp. 236-238; Tsang, 2014, pp. 178-182), which should be analyzed in order to obtain reliable conclusions of the validation test, and results which are reproducible and of a scientific nature. The dominating opinion suggests to conduct from four to ten variants of case studies (Eisenhardt, Grabner, 2007; Yin, 2009). Taking into account the specificity of spare parts availability management in manufacturing enterprises, the Authors stated that performing an empirical analysis for at least four variants of the case study will provide the validation of the developed model.

# 5. EMPIRICAL VERIFICATION OF THE CONTROLLING SYSTEM IN THE MANAGEMENT OF SPARE PARTS AVAILABILITY

In order to conduct the empirical verification, it was decided to adopt for analysis the spare part which was assessed as the critical one, from the point of view of assurance of production process continuity. Table 3 presents the detailed characteristics of the analyzed spare part.

<b>Table 3.</b> Spare part A characteristic A (A4 variant) adopted for the verification of
the developed model

Criterion	Actual variant characteristic
Work mode	Unplanned
Group according to the criticality criterion	Critical
Groups according to the consumption frequency (123 classification)	1
Does the Maintenance have authorizations for execution of the repair using the given spare part?	Yes
Who bears the costs of delivery from the supplier to the enterprise?	Enterprise
Is equipment for the transport of a spare part from the supplier to the enterprise needed?	Yes
Does the enterprise have such equipment?	Yes

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Who is responsible for the organization of the transport from the supplier to the enterprise and who implements it?			
Is the time of preparation of the device for the repair longer than the time of delivery of a spare part?	No		
Subject of the purchase	Material		
Place of storage of spare parts	Enterprise		
The owner of the spare part	Enterprise		
Party responsible for making the decision on the volume and time of ordering the spare part	Enterprise		
Will the spare part be used immediately after delivery to the enterprise?	No		
Who performs the transport from the warehouse to the place of repair?	Enterprise		

Source: own study based on data from a manufacturing enterprise

Presentation of the spare part specification was made in A4 variant, which is a reference variant, based on the real data obtained from the enterprise. Under the empirical verification using the case studies, the variants which differ in the adopted methods of supplementation of the spare part stock were used.

Performing the analysis of the costs of spare parts availability management, in the first step, required the collection of cost data (Table 4) and then determining the individual costs evaluating this area (Table 5).

Variants		A0	A1	A2	A3	A4	A5
Cost of placing an order with the	cost of one order associated with the purchase of a spare part	10.00	10.00	12.00	14.00	14.00	12.00
supplier for the purchase of a spare part	number of placed orders for the purchase of a spare part	67.00	67.00	52.00	45.00	45.00	52.00
Cost of placing an order with the	cost of one order associated with the purchase of a repair service	0.00	0.00	0.00	0.00	0.00	0.00
supplier for the purchase of a service	number of placed orders for the purchase of a repair service	0.00	0.00	0.00	0.00	0.00	0.00
Cost of placing an order with the	the sum of the cost of one order associated with the purchase of a spare part and a repair service	0.00	0.00	0.00	0.00	0.00	0.00
supplier for the purchase of a material and service	number of placed orders for the purchase of a spare part along with a repair service	0.00	0.00	0.00	0.00	0.00	0.00
	number of deliveries	67.00	67.00	52.00	45.00	45.00	52.00
Costs of transport with own fleet from	number of kilometers to be traveled by the individual means of transport	220.00	220.00	220.00	220.00	220.00	220.00
the supplier to the	cost of 1 kilometer for the given means of transport	1.30	1.30	1.50	1.60	1.60	1.50
warehouse	cost of operation of the used means of transport	13,266.00	13,266.00	9,152.00	6,930.00	6,930.00	9,152.00
	number of individual means of transport	1.00	1.00	1.00	1.00	1.00	1.00
Costs of transport	number of deliveries	0.00	0.00	0.00	0.00	0.00	0.00
with own fleet from the supplier to the	number of kilometers to be traveled by the individual means of transport	0.00	0.00	0.00	0.00	0.00	0.00
place of repair	cost of 1 kilometer for the given means of transport	0.00	0.00	0.00	0.00	0.00	0.00

Table 4. Data for determining the spare parts availability management costs

Variants	A0	A1	A2	A3	A4	A5	
	cost of operation of the used means of transport	0.00	0.00	0.00	0.00	0.00	0.00
	number of individual means of transport	0.00	0.00	0.00	0.00	0.00	0.00
to the warehouse	ne carrier from the supplier	0.00	0.00	0.00	0.00	0.00	0.00
Costs of transport by the to the place of repair	0.00	0.00	0.00	0.00	0.00	0.00	
Costs of transport of a spare part from the	number of deliveries (number of warehouse releases)	0.00	0.00	0.00	0.00	0.00	0.00
warehouse to the place of repair executed by the external company	Costs of transport of one delivery of the spare part from the warehouse to the place of repair executed by the external company	0.00	0.00	0.00	0.00	0.00	0.00
~	number of deliveries (number of warehouse releases)	61.00	61.00	61.00	61.00	61.00	61.00
Costs of transport of a spare part from the warehouse to the	number of kilometers to be traveled by the individual means of transport	6.00	6.00	6.00	6.00	6.00	6.00
place of repair	cost of 1 kilometer for the given means of transport	1.40	1.40	1.40	1.40	1.40	1.40
executed by the enterprise	cost of operation of the used means of transport	311.10	311.10	311.10	311.10	311.10	311.10
enterprise	number of individual means of transport	1.00	1.00	1.00	1.00	1.00	1.00
Cost of support of warehouse processes	number of the given spare part accepted to the warehouse (results from the volume of acceptances)	300.00	300.00	300.00	300.00	300.00	300.00
within the scope of acceptance	unit cost of acceptance of the given spare part	1.39	1.39	1.25	1.10	1.10	1.25
Cost of storage of the	average volume of the spare part stock stored in the warehouse	29.00	29.00	30.00	31.00	30.00	24.00
spare part stock	unit cost of storage of the given spare part	3.33	3.33	3.33	3.33	3.33	3.33
Cost of support of warehouse processes	the number of spare part subject to completion	268.00	268.00	268.00	268.00	268.00	268.00
within the scope of completion	unit cost of completion of the given spare part	2.08	2.08	2.08	2.08	2.08	2.08
Cost of support of warehouse processes within the scope of	the number of the given spare part released from the warehouse (results from the volume of releases)	268.00	268.00	268.00	268.00	268.00	268.00
release	unit cost of release of the given spare part	1.25	1.25	1.25	1.25	1.25	1.25
Cost of spare part main	ntenance in the warehouse	22,555.32	5,914.14	5,914.14	6,118.08	6,322.02	6,118.08
Price of spare part pure	chase	1,019.68	1019.68	1019.68	1019.68	1019.68	1019.68

Source: own study based on data from a manufacturing enterprise

Table 5. Costs of management of spare part availability in the	individual variants
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Variants	AO	A1	A2	A3	A4	A5
Cost of placing an order with the supplier for the purchase of a spare part	670	670	624	630	630	624
Cost of placing an order with the supplier for the purchase of a service	0	0	0	0	0	0
Cost of placing an order with the supplier for the purchase of a material and service	0	0	0	0	0	0

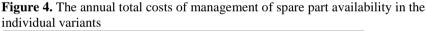
#### Operational controlling in the management of spare parts availability

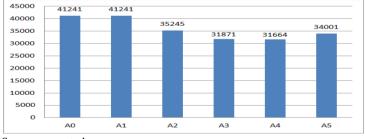
Total cost of assurance of spare part availability	41241	41241	35245	31871	31664	34001
Cost of spare part maintenance in the warehouse	5914	5914	6118	6322	6118	4894
Cost of support of warehouse processes within the scope of release	335	335	335	335	335	335
Cost of support of warehouse processes within the scope of completion	557	557	557	557	557	557
Cost of storage of the spare part stock	97	97	100	103	100	80
Cost of support of warehouse processes within the scope of acceptance	417	417	375	330	330	375
Costs of transport of a spare part from the warehouse to the place of repair executed by the enterprise	824	824	824	824	824	824
Costs of transport of a spare part from the warehouse to the place of repair executed by the external company	0	0	0	0	0	0
Costs of transport by the carrier from the supplier to the place of repair	0	0	0	0	0	0
Costs of transport by the carrier from the supplier to the warehouse	0	0	0	0	0	0
Costs of transport with own fleet from the supplier to the place of repair	0	0	0	0	0	0
Costs of transport with own fleet from the supplier to the warehouse	32428	32428	26312	22770	22770	26312

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Source: own study based on data from a manufacturing enterprise

In order to interpret the results, the variants which differ by the adopted methods of supplementation of spare parts stock were selected (Fig. 4).





Source: own study

Under the analyzed group of variants, the lowest total costs were achieved by A4 variant, so the recommended one. Therefore, it can be concluded that the selected method of spare parts stock supplementation is appropriate for the given spare part with the remaining criteria assumed.

The factor supplementing the controlling analysis is the evaluation of the efficiency of spare part availability management using the developed system of indexes. For this purpose, for validation of the model, the additional operational data, necessary for effective evaluation of the efficiency of the analyzed process were used.

Data necessary for performing the analysis of the efficiency of spare part availability management come from the manufacturing enterprise and are presented in Table 6.

	Variants	A0	A1	A2	A3	A4	A5
Reactivity of	number of spare parts delivered before the deadline	10	10	12	10	10	12
delivery (W1)	total number of the delivered spare parts	268	268	268	268	268	268
Index of transportation	transportation time	29	29	24	18	18	24
demand (W2)	total number of deliveries	67	67	52	45	45	52
Warehouseman work efficiency	volume of turnover of spare parts stored within the given period	268	268	268	268	268	268
index (W3)	average number of employees in the warehouse	1	1	1	1	1	1
Index of labor intensity of the stored spare parts	number of warehouse employee's working hours within the given period	0.27	0.27	0.27	0.27	0.27	0.27
releases (W4)	volume of releases of the stored spare parts	268	268	268	268	268	268
	average spare parts stock in a given period	29	29	30	31	30	24
Coverage ratio (W5)	volume of consumption of spare parts in a given period	268	268	268	268	268	268
	number of days in a given period	365	365	365	365	365	365
Index of share of not rotating stock	value of not rotating spare parts stock	0	0	0	0	0	0
in the stock (W6)	total value of spare parts stock	295 71	295 71	305 90	316 10	305 90	244 72
Index of timeliness	number of deliveries executed on time	67	67	52	45	45	52
of deliveries (W7)	total number of deliveries in a given period	67	67	52	45	45	52
Balance of completed orders	number of units of a particular spare part delivered by the suppliers in a given period	300	300	300	300	300	300
(W8)	total number of units of a spare part ordered in this period	300	300	300	300	300	300

**Table 6.** Input data for the analysis of the efficiency of spare parts availability

 management

Source: own study based on data from a manufacturing enterprise

Due to the fact that measures of particular indicators also concern various material flow processes, which directly affect the continuity of the production process, all the designated indicators are considered equivalent.

In order to evaluate the efficiency, a score comparison method was developed for individual results of efficiency analysis. The scale of obtained points was determined on the basis of the hierarchy of results obtained from a given indicator. Table 7 presents a scoring scale for particular places in the hierarchy.

Table	7.	Scoring	scal	le
Lanc	<i>'</i> •	Scoring	sca	l U

I place	II place	III place	IV place	V place	VI place
10 points	8 points	6 points	4 points	2 points	0 points

Source: own study

Summary of results for individual indicators and ranking of variants (total points obtained by the analyzed variants) are presented in Table 8.

	Results of efficiency analysis									Points obtained according to the scale							
	W1	W2	W3	W4	W5	W6	W7	W8	W1	W2	W3	W4	W5	W6	W7	W8	Total
A0	3.73%	0.43	268	0.001	39	0%	100%	100%	8	8	10	10	8	10	10	10	74
A1	3.73%	0.43	268	0.001	39	0%	100%	100%	8	8	10	10	8	10	10	10	74
A2	4.31%	0.46	268	0.001	41	0%	100%	100%	10	6	10	10	10	10	10	10	76
A3	3.73%	0.40	268	0.001	42	0%	100%	100%	8	10	10	10	10	10	10	10	78
A4	3.73%	0.40	268	0.001	41	0%	100%	100%	8	10	10	10	10	10	10	10	78
A5	4.31%	0.46	268	0.001	33	0%	100%	100%	10	6	10	10	6	10	10	10	72

Table 8. Results of efficiency assessment

Source: own study based on data from a manufacturing enterprise

The presented results of total costs and the assessments of the efficiency of providing spare parts availability confirm that the most reasonable solution is A4 variant, i.e. the variant indicated by the controlling system (in a limited space for the consideration of variants – the quasi-optimum variant). Therefore, this analysis confirms the correctness of the logic of the developed controlling system for managing the availability of spare parts.

# 6. CONCLUSION

The issue of the availability of spare parts is an important element of the efficient management of a production enterprise that requires in-depth analysis and research. There is no unequivocal solution in the current scientific work on the scope and method of analyzing the availability of spare parts in terms of maintenance of continuity of the production process. The lack of a defined method of comprehensive network analysis of factors influencing the spare parts availability management process prevents making proper decisions in this regard. Research conducted by the Authors confirm the need to implement three basic elements within the comprehensive analysis of spare parts availability: analysis of securing the needs of production continuity, analysis of the selection of methods of spare parts' completion and controlling analysis. In this article, the Authors focused only on the third element that enables the assessment of the effectiveness of spare parts availability management.

The validation procedure conducted using case studies of 6 variants confirms the complexity of managing the availability of spare parts to ensure continuity of the production process. Using the case-study-based research method, a multidimensional analysis was carried out, which allowed to verify the defined variants. The empirical research discussed in this article also confirms the possibility of using the developed tool in a spreadsheet to conduct prognostic analyses of efficient assurance of the availability of spare parts in the production process.

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# **III. PURCHASING LOGISTICS**

# 7 STEPS OF CHANGING A PURCHASING STRATEGY EXEMPLIED BY A SELECTED ENTERPRISE

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### Abstract

Purchasing took significance in time of global competition for resources and customers. It is one of the supply chain elements and provide resources needed to produce finished goods. The goods create a value for final customers. The term "strategic sourcing" emphasises the purchasing influence on constructing business action plans. Problems in field of purchasing strategy of enterprise directly affect its financial results. The aim of this paper is a presentation of concept developed on base of researched case study of 7-step-change of purchasing strategy. Elaboration of the idea was preceded by analysis of current state and by identification of key problems in area of purchasing strategy of audited company. Current state was analysed by using CRT and FMEA. The concept of 7-step-change of purchasing strategy, adapted to working conditions of examined company, was proposed basing on results of analysis. Its usefulness was also pointed out for other enterprises that fulfil specific conditions of activity.

**Key words:** purchasing strategy, analysis and identification of problems, concept of change of purchasing strategy

# **1. INTRODUCTION**

The times when the margin was only regulated by the sales price are definitely over. The Internet development caused almost unlimited access to the information on resources, their localisation, accessibility and acquisition costs. The Internet also became an invaluable comparative tool in the process of making business decisions. The process was shortened to its minimum by immediate and direct communication with numerous potential partners. This is used by all parties of each buy-sell transaction. Such a defined operation transparency brought considerable changes in shaping both the production costs and the price policy of business entities. The enterprises, which were functioning at the global market beforehand, improved their processes. This was accompanied by the newly occurred changes. As regards to many of the enterprises, the changes were a turning point and contributed to redefining the conducted business activities. There still remained a certain group of enterprises which treated the generalisation of the resource access very selectively, i.e. to such extent as it was required by the situation at the market of that time.

# 2. A CHANGE OF THE PURCHASING DEPARTMENT ROLE

Globalisation is "the removal of free trade barriers and international close economy integration" (Stiglitz 2004, p. 7) and provides numerous adavantages but can also cause an economic crisis (Gills, 2007; Keeley & Love, 2010). The 2007 economic collapse contributed to revaluating certain world economy functioning areas and revalauting the activity of enterprises in a microscale. One of such areas is purchases which were indicated in the 2012 report entitled "The role and importance of purchases in Polish enterprises" by the Marketplanet counselling enterprise and the Polish Association of Logistics Managers (Filipowski et al., 2012, p. 28) as a key area of direct influence on being successful in the conducted business.

The above thesis is supported by the definition of a supply chain with respect to its formational processes. The supply chain is a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage (Harrison & van Hoek, 2014, p. 8). To make it more precise, it is necessary to add that the mere process of transforming materials and information into products and services is the production phase. Thereby, the supply network (chain) includes purchases as one of its stages by giving them strategic meaning in the process of making economic decisions (Adamczak et al., 2016).

The purchasing globalisation also has dangers that have been investigated for a decade only (Stanczyk et al., 2017). There is a great variety of purchasing strategies in the reference literature. The strategy selection depends on individual decisions of an enterprise (Hadas et al., 2011). The evolution of procurement departments made the traditional model changed into suppliers' management (Bevilacqua & Petroni, 2010). The traditional model relied on purchasing production means (Lidegaard et al., 2015). Purchases are more and more integrated with other enterprise functional areas – strategy specification, marketing, supply chain management and the entire enterprise management. The further development trends are related to honest, balanced and digitalisation-followed purchases, risk management in the supply chain and purchases in the public sector. The Kraljic matrix (Kraljic, 1983), TCO concept (Ellram, 1993) or normative strategies (Skowronek & Sarjusz-Wolski, 2008, p. 158) indicate possible trends of changes in purchasing strategies.

# **3. CASE STUDY**

The investigated enterprise exemplifies the activity in producing electronic devices. The enterprise adapted to ongoing changes in economy and technology in a fast way.

The purchasing activity includes the cooperation with national and European catalogue distributors of electronic components and the already direct cooperation with manufactuers of plastic casings and selected Asian electronic components. Non-standard elements are a significant share in the purchases. The elements make it possible to adapt goods to the customers' wishes. The finished goods recipients are mainly chains of retail stores inland and abroad. They bring 95% of the enterprise revenue and ensure its dominating share at the national market. This family business formula comes from the owner's personal perfomance of all the works. This is presently manifested by the central planning of each action and its performance supervision, precisely according to the owner's guidelines.

The purchase manager noticed the need for the purchasing strategy adaptation to the functioning conditions of the investigated enterprise. In the purchasing process one introduced such minor corrections as the separation of the purchases from the production department, first buffer inventories in the suppliers, and partial consolidation of purchases. These minor corrections with keeping the same resource size did not bring the expected results. One decided to perform a profound analysis of the current situation and introduce strategic changes to the purchasing area.

The authors' case study analysis aims at making an attempt to find a method of making changes to the purchasing strategy in enterprises of similar kind. It is necessary to assess the current purchasing strategy of the investigated enterprise to indicate a trend of its changes.

# 3.1. Current State Analysis

The everyday purchasing department activity is largely influenced by its relations to other enterprise departments. The enterpise board specifies current procurement priroties and its additional tasks whereby there are separate lists of additional tasks for the enterprise chairperson and the executive director. Furthermore, the board determined a two-week order processing date that should be included in trade offers for customers. The date includes the time for delivering components, manfacturing products and their delivery to the customers. As regards to the **national and foreign sales departments**, it is a practice to declare immediate deliveries. The salesmen's active action system is oriented to an always unexpected customer's order and this makes it impossible for an action plan to be executed on its development day. This plan is determined every morning by purchases. The vesterday-planned request and demand are made and related to both large quantities and minor transactions. The renumeration system of the salesmen is of key importance in this case. The sales person gets a commission from each, even the smallest transaction. The orders introduced to ERP are processed by the production department from which a planner moves them to the purchase department as generated order shortages. Skirmishes between the above departments are on a daily

basis. This is caused by no production components and no chance to meet the supply deadline. The skirmishes end up with time-consuming meetings in the board office to make a step-by-step explanantion of the situation. Apart from the inventory shortage policy, one also detects mistakes in ERP production recepies, delays in production settlements, i.e. the warehouse state update. There is usually some information from the warehouse on bringing out last component items from its stock. In this way the purchasing department is supported in faster reacting to such a situation. Once the items ordered by the purchasing department are accepted to the warehouse, the goods received note (GRN) is passed by the warehouse to the purchasing department to get it verified in terms of its content and quantity. The information on possible supply shortages are transmitted in the same way whereas deviations from the specified quality requirements are reported by the quality control department and the purchasing department conducts further complaint proceedings. In this area there are common quality tests of trade goods. Their results are then announced to the sales departments. The research and development (R&D) department makes a list of materials and services to be used in new projects and passes it to the purchasing department in order to find new suppliers and specify the purchase prices. Samples of components for the sake of pre-production tests are also purchased by the purchasing department as commissioned by the R&D department. At this stage one also forms appropriate warehousing indexes in ERP which are then used by R&D. The cooperation with the accounts and financial department is crucial in the case of the purchasing activity. On the one hand, the cooperation means the document circulation and completeness control. On the other hand, it means making fast payments to Asian suppliers who will start executing their orders from the investigated enterprise as soon as prepayments are posted in their bank accounts. One should also mention a foreign department subordinate to the purchasing department in Poland in its operational area. All trade and customs documents related to purchasing transations need to be sent to an accountant in that country.

In the enterprise there is also a service department, although it is formally located in the sales department. A service coordinator manages a group of external technicians who perform ready-make goods installation and servicing. The purchasing department satisfies the service demand for tools and materials to execute servicing tasks and provides necessary manuals and technical documentations of external suppliers' systems.

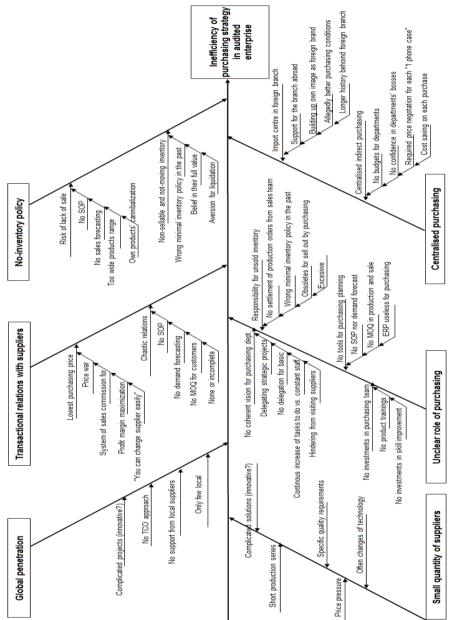
No production components were the embers of most conflicts in the investigated enterprise. The conflicts were not eased by the parties' knowledge of the reasons for the lack. On the one hand, the domestic sales and export departments did not provide any forecasts related to their activity. On the other hand, the inventory formation was prohibited in the enterprise. This ban was implied by no forecasts and large amounts of yet unusable components lingering in the warehouse as a result of carefree sales and production planning a few years beforehand. For the above reason the owner decided to purchase the amount of components and goods exactly according to their customer's order.

Such a formulated purchasing strategy element, actually an inventory management element, exhausted the enterprise ability to manage the processes efficiently. Due to the lack of components there were expensive production

stoppages. The purchasing department "stopped the fire" by frantically getting parts in an express pace and still in the amounts according to the customer's order. The salesmen excused themselves to their customers for the ready-made goods supply dates which were longer than declared. On the other hand, any inventory left after the completed production order was profoundly analysed with respect to the reason for purchasing its larger amount and was named as "excessive". The R&D department participated in the above process. As an electronics development follower, the R&D department modernised the present solutions and equipped new products with the newest components. In the wake of the modernisation the production recipes needed to be regularly changed and enriched by the solution multi-optionality – their "custom sewing". This leaded to increasing the number of goods with a diverse internal structure. The purchasing department played a typically operational role oriented to the fast and cheapest supply.

The identification of problems in the purchasing strategy area of the investigated enterprise was begun by mentioning such symptoms that could be potential limits in conducting the purchasing activity. The limits were considered to include: lacks of production components and goods – frequent corrections of production plans and production based on the "list of shortages", no information on the real demand for production components and goods.

In order to identify the source causes of the noticed symptoms one identified the problems which were implied by the purchasing strategy of the investigated enterprise. This was started by developing an Ishikawa diagram. The analysed problem was formulated as follows: "The purchasing strategy inefficiency in the investigated enterprise". Selected elements of the present purchasing strategy were used as problem categories. The analysis results are presented in Figure 1.





Source: own elaboration.

It is implied by the above diagram that the causes of the previously defined problem symptoms are:

- no Sale and Operational Planning team
- no sales forecasting
- cannibalisation of their own solutions
- lingering and yet non-sellable inventory as a succession of the safety stock that was wrongly calculated in the past.

Thereby, it was proven that there was no foundation which is purchase planning and the inventory level specification in the case of the procurement department (Sincic Coric et al., 2017). As a result, the investigated enterprise made purchases exactly when it received a customer's order. This meant a huge time pressure and a risk of no components in the suppliers. Such conceived purchases were oriented to fast action with no partnership elements and no bargaining position construction.

The next analysis element was to form a Current Reality Tree (CRT) (Goldratt, 1994, p. 94) of the investigated enterprise – Figure 2.

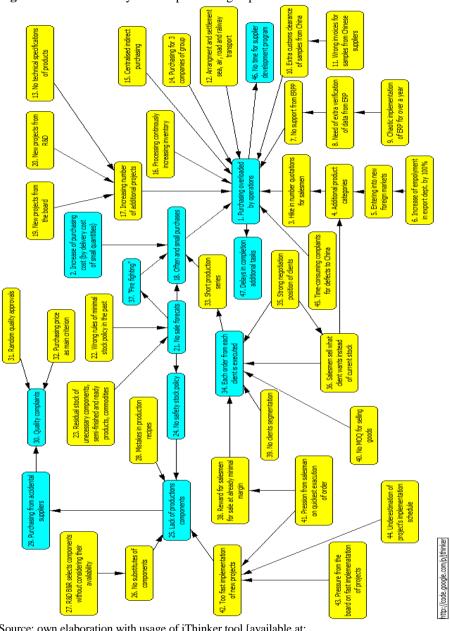


Figure 2. Current Reality Tree in purchasing department

Source: own elaboration with usage of jThinker tool [available at: https://code.google.com/archive/p/jthinker/downloads, access November 30, 2016]

During the CRT construction one identified the major problem which was called as "overloading the purchasing department staff with the number of a dispatching operations". In this way a hierarchy of problems and their causes was specified but it did not reflect their significance. The "lack of production components" was the greatest challenge in everyday work. The tree of its causes was much more complex and was related to most internal processes in the enterprise.

The FMEA analysis (Tague, 2004) was prepared based on such selected problems and their causes. In the next stage, the analysis was transformed into a corrective actions coverage of problems matrix according to most probable dangers as presented in Table 1.

Corrective Action (CA) /Problem (P)	Risk Priority Number RPN per CA	Q-ty of Failures (F)	Q-ty of Undesired Effects (UDE)	Part of total RPN (%)
CA1	RPN1	F1	UDE1	RPN1/RPN
P1	RPN (P1)	P1F	P1UDE	RPN (P1)/RPN
P2	RPN (P2)	P2F	P2UDE	RPN (P2)/RPN
P3	RPN (P3)	P3F	P3UDE	RPN (P3)/RPN
P4	RPN (P4)	P4F	P4UDE	RPN (P4)/RPN
CA2	RPN2	F2	UDE2	RPN2/RPN
P5	RPN (P5)	P5F	P5UDE	RPN (P5)/RPN
P6	RPN (P6)	P6F	P6UDE	RPN (P6)/RPN
•••	•••		•••	
CAx	RPNx	Fx	UDEx	CAx/RPN
Px	RPN (Px)	PxF	PxUDE	RPN (Px)/RPN

Table 1. Corrective actions coverage of problems matrix

Source: own elaboration

Corrective Action CA1 covers problems P1...P4 and is sorted by diminishing Risk Priority Number RPN. In particular cases RPN can be misleading because it attempts to quantify risk without adequately quantifying the factors that contribute to risk (Sankar & Prabhu, 2001). F1 specifies the number of errors which might be eliminated by the CA1 corrective action and corresponds to the sum of problems P1...P4. The UDE1 value is a total number of undesired results which be removed

due to the CA1 implementation. The last column indicates an RPN1 share in the RPN sum in the case of all CA. Such a developed matrix suggests a sequence of corrective actions starting from the most frequently mentioned to the most highly assessed failures.

16 failures, 26 results, 52 causes and 32 unique corrective actions were identified in the investigated enterprise. Such a variety of the detected phenomena excluded the Pareto Principle and meant a necessity to undertake numerous initiatives to improve the situation.

The above research was supported by the customers' ABC analysis that showed as much as 94% of the group A customers in the total sales volume of the enterprise. This gave an impulse to review the sales policy and to clearly indicate its further direction. Such actions should be translatable into shaping the purchasing strategy and the purchasing department operational functioning.

# **3.2.** The Concept of the 7-step Purchasing Strategy Change in the investigated enterprise

A source cause of developing the concept of the 7-step purchasing strategy change was to overcome the resisitance of changes at the level of both the enterprise board and departments directly related to the purchasing department, i.e. the sales department and the R&D department. The objections were all the more motivated as the departments appeared to <u>have no ability to asorb the changes with no large impact on their work (introducing minor corrections in the purchasing process)</u>.

It is assumed by the developed concept of the 7-step purchasing strategy change in the investigated enterprise to fulfill 7 consecutive steps as presented in Table 2.

Step	Step name	Short description
1	Present purchasing strategy assessment	This step relies on both the qualitative and quantitative assessment of the currently functioning purchasing strategy. The recommended methods to be applied within this step are: Ishikawa diagram, current reality tree, system virus analysis (Cyplik & Hadaś, 2015, p. 315) and indicator analysis. This step aims at identifying the present strategy advantages and disadvantages and major problems/challenges and their source causes.
2	Knowledge complement	This step relies on presenting a theory related to the purchasing strategy role in the enterprise strategy by means of workshops with an internal and external coach. The workshops are intended to present major role that should be played by the purchasing

**Table 2.** The Concept of the 7-step Purchasing Strategy Change in the investigated enterprise

Step	Step name	Short description
		department in the enterprise at the strategic, tactic and operational level. The workshops also aim at presenting the possibilities to apply contemporary tools to manage this area. This stage aims at making the decision-makers conscious of the purchasing role in the enterprise based on contemporary market trends.
3	Change necessity realisation	This step relies on analysing the problems/challenges that were identified in the first step by means of qualitative methods. This step also relies on analysing key performance indicators (KPI) of the assessment. Benchmarking is the method applied in this step. This stage aims at convincing decision-makers of the necessity to make changes in the purchasing area based on potential measureable results of the introduced changes.
4	Change-related benefit indication	This step relies on diagnosing the benefits of potential changes in the purchasing strategy. As part of this step, one analyses potential benefits of changes in the investigated enterprise with reference to the benchmarking- implied indicator levels. One analyses i.a. the financial result that would be possible to obtain in the case of the improvement of the KPI indicator values in the purchasing area compared to the values obtained by other enterprises. As part of this step one compares what cost should be carried to increase the margin by 1% by actions in the sales area and what costs by actions in the purchasing area. This stage aims at understanding the limited possibilities to generate enterprise benefits that are implied by the present purchasing strategy or inappropriately selected strategy fulfilment tools.
5	Analysis of possible change variants	This stage relies on diagnosing possible methods of improving the purchasing area functioning in the enterprise. One makes a list of methods to achieve the objectives set in the purchasing area – the list covers all the identified problems within step 1. To fulfil this step, one might use the FMEA analysis results.

## 7 steps of changing a purchasing strategy exemplied by a selected enterprise Jarosław Milczarek, Piotr Cyplik, Sebastian Wieczerniak

Step	Step name	Short description			
		One discusses possible actions related to			
		achieving strategic objectives in the purchasing			
		area within the modified purchasing strategy.			
		This stage aims at developing variant methods			
		of eliminating the problems identified in step 1,			
		preparing the organisation to get changed and			
		selecting the best purchasing strategy adjusted			
		to the enterprise limits.			
		This step relies on proposing a change in the			
		purchasing strategy. The strategy is implied by			
		new possibilities as presented in the previous			
6	New purchasing	stages and apparently indicates the differences			
	strategy proposition	from the present activity methods.			
		This stage aims at presenting a proposition that			
		will not only enhance the efficiency of the			
		purchasing department activity but also			
		improve the entire purchasing process.			
		This step relies on indicating corrective actions			
		which are implied by the conducted present			
		purchasing strategy analyses. The actions			
		should be implemented in other enterprise			
		departments. At this stage a division of			
		responsibility for implementing the actions in			
		particular departments need to be specified.			
		The RACI matrix is a tool to perform the			
7	New purchasing	specification (Works & Price, 2017).			
	strategy transfer	This stage aims at making the decision-makers			
		realise the necessity to introduce changes			
		outside the mere purchasing department to			
		obtain real benefits from the new purchase			
		strategy. The success key is to make the			
		decision-makers understand mutual relations			
		between purchases and other areas. Thereby,			
		the strategy becomes a prime mover of positive			
		changes in the entire enterprise.			

Source: own elaboration

The Concept of the 7-step Purchasing Strategy Change is considered to be a thought process that treats the considered problem in a complex way. The identification of problems/challenges in the purchasing area was a point of departure in the investigated enterprise. The identification was a basis of the more profound analysis of the fulfilled purchasing strategy. Due to applying the problem identification and analysis method one identified basic problems/challenges of the purchasing area in the investigated enterprise. To visualise the problems/challenges one used the Ishikawa diagram (Figure 1) and CRT diagram (Figure 2).

In step 2 there were internal trainings in which an internal coach (the coach was a purchasing department manager – a recent MBA programme graduate) presented the theoretical foundations of the purchasing role in enterprises with respect to current market trends. As part of the workshops one found considerable differences between the purchasing area functioning in the investigated enterprise and the current market trends.

As part of step 3 one performed a profound analysis of the step 1 results. One compared quantitative data (indicator analysis) with the results of the quantitative analyses. As a result, one confirm the current purchasing strategy unadjustedness to the enterprise functioning conditions. The comparison of major KPI indicator values in the investigated enterprise with indicators of other enterprises (within benchmarking) revealed that all of them are considerably under the values obtained by their competitors.

Step 4 relied on calculating potential cost reduction and revenue increase possibilities. The KPI indicator values obtained in the benchmarking-compared enterprise were used to do the calculations. The works resulted in a potential possibility to improve the financial result by more 25%. The result was measured as ROS. This result comes from the revenue leverage. It states that the procurement cost decrease by 1 dollar results in increasing the gross revenue by 1 dollar, whereas the sales increase by 1 dollar results in increasing the gross revenue by the one-dollar margin only. The second procurement cost decrease effect is the decrease in the goods inventory value, i.e. assets value. Thereby, the ROA indicator (revenue/total assets \*100%) of the investigated enterprise has an increasing potential by more than 20%. This is if the sales income amount is assumed to be maintained.

As part of Step 5 one performed the FMEA analysis. Due to the analysis one selected the solutions (one made a list of corrective actions) that cover the diagnosed problems in the purchasing area (cf. Table 1). One also discussed possible actions related to achieving strategic goals in the purchasing areas within the modified purchasing strategy. The proposed solutions are intended to increase the purchasing area efficiency.

In step 6 of the 7-step concept as implemented in the enterprise one proposed the purchasing concept changes and the strategic role increase of the purchasing department in the enterprise. The changes will be related not only to the relations with the suppliers but also to a different location of the purchasing department in the enterprise structure and to the changes in the mere department. The proposed changes developed within this stage are presented in Table 3.

Purchasing strategy elements	Approach within the strategy			
Turchasing strategy elements	Before changes	After changes		
Insourcing/outsourcing	Own production first and then outsourcing	Insourcing calculated based on sales forecasts, BEP and ROI		
Number of suppliers	Unimportant	Diversification of supply sources Max 75% of the supplier's share in the purchasing category		

Table 3. Assumptions of new and former purchasing strategy

	Approach within the strategy		
Purchasing strategy elements	Before changes	After changes	
Penetration areas	First of all China	Global and local, including TCO	
Type of relationships	Transactional	Partnership for strategic goods and "bottlenecks" Transactional for standard goods and "leverages"	
Supplier selection criteria	Price and delivery	ТСО	
	time	Audits and assessment of the supplier	
		Segmentation of suppliers	
Centralisation	Full	Direct purchases - full	
		Indirect purchases - competency delegation to departments	
Inventory management	Full availability- informal buffer	Safety stock based on sales forecasts	
	inventory in the suppliers	Buffer inventories (liquidatable) at 4 supply chain levels based on forecasted sales	
Purchasing start	Purchase according to the customer's order	Connection of the make to stock logic with the make to order logic	
	(make to order logic)	Search for a scale effect in cumulated purchases	
Purchasing role in the organisation	Operational,	Operational, tactical	
	tactical	Strategic	

Source: own elaboration

Step 7 was very meaningful in the context of broadening the implementation areas of the proposed changes with other enterprise functional areas. One added RACI analysis elements to the list of corrective actions as made in step 5. This unambiguously identified the places of making changes (organisational cells). In this way one obtained a matrix of changes implied by the decision about correcting actions in the purchasing

areas with reference to all the enterprise organisational cells. The decision-makers got the arguments to introduce changes in the entire enterprise. The changes will lead to the expected results which are implied by the purchasing strategy change.

#### 4. CONCLUSION

The purchasing area is more and more appreciated and became an essential link in the entire enterprise structure as a purchasing budget disposer. The purchasing area is still grappling with challenges that are both implied by its internal organisation and derived from other organisation areas. No cooperation of particular enterprise cells causes difficulties in efficient purchase management. A particular case is that the decision-makers do not realise the chances of an efficient purchasing strategy and its influence on the entire organisation activity. Everyday purchasing department experiences give appropriate, measurable and logical agruments and might be an inspiration to introduce serious changes in numerous aspects.

The case of an enterpise with the above needs noticed gave rise to developing the concept of the 7-step purchasing strategy change. The concept describes the step sequence in detail and gives hints of how the steps might be used in similar cases. Thereby, the concept becomes universal. Noticeably, initators of the purchasing strategy change might encounter implementation barriers that might occur in each of 7 steps of the presented concept. In such a situation one should take a step backwards and reanalyse the previous step results profoundly. In the authors' view the developed concept is a cohesive whole and enables smooth purchasing strategy implementation in the enterprise.

The authors performed research on another 2 family enterprises (of the furniture industry) and stated that they had problems similar to the ones as described in the investigated enterprises in this article. The purchasing department managers in those enterprises initatated the modification process of the purchasing strategies based on the Concept of the 7-step Purchasing Strategy Change.

The proposed concept efficiency is especially high in family enterprises that are managed by their owners in an authoritarian way. The owners cultivate their habits and courses of action adopted at the business activity beginning. These methods are all the more cultivated if they were successful. The owners create action procedures of their enterprises based on the habits and methods and expect their unconditional execution. This is how the owners create their image of the only leader and the source of determining the most efficient courses of action in their team. These owners are the most resistance to change their habits. The reason for their resistance is no trust in the employed managers, unwillingness to delegate competences and the confidence in their own methods only. Finally, the owners are simply afraid of the own enterprise future. Furthermore, such a dominated environment of employees are the most endangered by inertia and the least susceptible to undertake content-based discussions. Therefore, it is efficient to make an application of the Concept of the 7-step Purchasing Strategy Change as presented in this article. In the first place, the concept application presents local benefits in the purchasing area which imply changes in the entire organisation in the next place. The argumentation is constantly based on indicating measureable benefits gained from the changes. The concept implementation has a positive influence on the financial result, increases the purchasing department significance and make the enterprise owner trust the purchasing department manager.

The presented 7-step Concept is intended to change the Purchasing Strategy Change which is its basic advantage. The change models in the reference literature e.g. 8-Step Process (Kotter, 2011), 10-Step Process (Pendlebury et al., 1998, p. 40, Kanter et al., 1992) or Deming's PDSA Cycle (Donnelly, 2015), present courses of actions which are admittedly applicable to investigate each process. Nevertheless, the authors' own Concept of the 7-step Purchasing Strategy Change is a ready tool to be applied in its respective area (purchases). The strategy provides a detailed description of each step by mentioning its essence, what actions should be undertaken within each step and what objective should be achieved. The strategy is characterised by being easy & ready to use for each purchasing manager.

The authors emphasize that an essential issue in any process of change planning and implementation is support from decision-makers. Described method presents a comprehensive analysis of purchasing strategy with use of Ishikawa diagram, benchmarking and KPI's as well as FMEA analysis. Obtained results can be verified by decision-makers on each stage of process. Conclusions and proposed correction actions are logical consequence of stated root causes. Purchasing is a well measured area and offer an opportunity to present positive results of arranged changes (e.g. improvement of OTIF, identifying and managing bottle necks, TCO implementation) basing on the Concept of the 7-step Purchasing Strategy Change. In this moment only the crucial indicators have been listed. More indicators should be applied according to balance scorecard (Kaplan & Norton, 2007) in course of the Concept implementation.

An added value of such developed concept is a clear indication that purchasing has a strategic role for enterprise. It is one of essential puzzles to achieve processes stable and efficient. It crosses over purchasing itself and reflects entire organisation. In this way a purchasing manager can contribute much more than operational proficiency. Transparency and logic in concept application as well as its holistic aspect enable to find a real synergy between internal processes of enterprise.

The Concept of the 7-step Purchasing Strategy Change creates a ground for future research on effectiveness of tools for implementation purchasing strategy changes in small and medium-sized family enterprise. Especial case is TCO concept which expresses level of organizational maturity to manage purchasing processes. This brings an obstacle at the same time – a limitation on access to such information from organisation from this sector.

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## ACTIVITY BASED COSTING AS A TOOL FOR EFFECTIVE USE OF OUTSOURCING IN SUPPLY CHAIN MANAGEMENT – CASE STUDY

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#### Abstract

The article presented herewith analyses Activity Base Costing usability to determine effective area and mode of outsourcing in supply chain based on a selected case. It is well established that ABC is a right method for establishing a comparable cost base for both typically considered generic scenarios: in-house and outsourced. Such comparison is to address a problem usually named as "make or buy". However such analyses are often made on general level and results are automatically applied to all activities. Moreover often a possibility to improve in-house operations in overlooked. In the case presented the appropriate calculating model was created and based on it, authors show potential of ABC method in creation of various scenarios leading to enhance efficiency of a supply chain. It is demonstrated with use of real case (however altered for academic purposes) study in Central Europe in an FMCG industry. The article contributes to the existing body of knowledge on the application of ABC method to measure efficiency of managerial decisions regarding use of outsourcing in supply chains. With the model presented companies may define scope and price level of outsourced services.

Key words: Activity Based Costing, make or buy analyses, outsourcing, supply-chain management

## **1. INTRODUCTION**

Activity Base Costing (ABC) is one of the most commonly used cost allocation methods. Credit for its scientific presentation is usually given to Cooper and Kaplan (1993), however attempts to use such approach had been earlier. ABC has several advantages over so called conventional allocation (Atrill & Laney, 2015). ABC is considered as a very useful method to evaluate outsourcing options as it directly identifies costs of internal processes allowing for their effective comparison to offers of external suppliers willing to take them over.

As logistic processes are relatively often outsourced (Dos Santos Gonçalves Leite, 2016), (Christopher, 2016) applying ABC to allocate costs and evaluating effectiveness in this area is quite common (Sliwczynski & Kolinski, 2012). A comprehensive overview of important scientific papers regarding application of ABC

costing in Supply Chain Management was presented by Hald and Thrane (2016). They indicated several particular application of the ABC in Supply Chain Management context (Pawlyszyn, 2017). Amongst others the following refer to outsourcing related decisions.

Primary they identified outsourcing as an important field since ABC provides a method that can calculate cost to the firm of using different suppliers as such accounting information proves useful for price negotiations. It has to be added in addition final decision about outsourcing vs. internal solution has to be based on an adequate cost comparison.

Secondly allocation of costs to customers has to be considered useful not only on sales side but also shall influence strongly an outsourcing decision as, even if external option proves to be in overall more efficient margins on certain groups of customers might be negatively affected.

Thirdly applying ABC based recommendations often leads to re-allocation of resources across entities. In order for such decision to bring positive effects an adequate cost/profit re-distribution mechanism must be developed to eliminate the involved parties' concerns for opportunistic behaviour (Hald & Thrane, 2016, p 10).

This article presents a case study illustrating how ABC can be used in order to capture the widest spectrum of parameters underlying an outsourcing decision and what mistakes can be made if an oversimplified approach is used. It is based on a real study made by authors for a commercial and still active Client which originally encompassed various confidential information. For the purpose of an article they had to be alternated. However a methodical ground and business context in the area of discussion is maintained.

## 2. A BUSINESS CONTEXT

#### 2.1. Market and characteristics

An internationally recognized toys producer, named "Super Toys" had a Polish branch with activities in Poland limited to logistics, sales & marketing. Products ranged from small, plastic figures to electronic devices and teddy bears exceeding in size a basket-ball player. The total number of active SKUs reached 500 but the ERP system in use carried several times more indices due to changes in packaging and suppliers. Customers represented three dominating segments: big retail chains, specialized shops (small shops with broader than toys product range were also included) and petrol stations (chains of).

Toys themselves were actually produced in China and Portugal and sent directly to a warehouse near Warsaw (in case of Asian direction with reloading in one of Baltic ports). Similar system functioned in all European countries. It was deemed inefficient as nearly 30 warehouses had to be operated with adequate inventory and wide assortment anyway caused troubles with meeting orders in full.

"Super Toys" was operating on very competitive market with low entrance barriers and shifting demand patterns. It's value in Poland is estimated between 0.5 and 1 billion USD. Although truly big global corporations were not directly active, opting for licensing mode of operations (like Walt Disney), five local producers took the lead (Cobi, Granna, Wader, Canpol and Trefl). They operated through different distribution channels however always utilizing the following ones: big retailers, specialized shops, general small retailers and petrol stations.

## 2.2. The outsourcing decision - targets and real results

Giving challenges outlined above and following general trend to centralize and standardize operations, create volume in order to streamline auxiliary processes Super Toys initiated a pan-European project aimed at centralization of all logistics operations from ex-works manufacturing up to deliveries to retail outlets. It ended with a recommendation of outsourcing of almost all activities. The one central warehouse was to be created near the barry point and supplied from both: own plant in Portugal and from China. From there deliveries were to be made directly to customers (exception were made for several very distant countries where crossdocking was to be applied).

Consequently, as of 1st of Jan. 2015, all logistics operations got outsourced to a renowned supply chain operator. As a result of a complex tendering offer a global operator: Swift Logistics was awarded the contract for 2 years with intention to expand it to an infinite time should both sides are satisfied with its performance. The contractor was made responsible for all warehousing activities (inbound, stocking, outbound) as well as for carrying deliveries from the European warehouse (from Frankfurt as near this city facility was located), directly to customers. Polish operations were be to charged only for the deliveries from Frankfurt. Consequently a cost structure became very simplistic. To the Cost of Goods Sold (COGS) defined as ex works Frankfurt a relevant delivery fee was added, which in turn was defined in two categories: per palette and parcel. Amongst other minor condition the Contractor warrantied 3 days delivery time to each place in Poland and 99% accuracy ratio.

Potential savings, in Poland only, consisted of the following:

- 1) an internally operated warehouse was shut down, eliminating roughly 2 million of annual costs;
- 2) upstream (deliveries to warehouse) and downstream (transport to
  - customers) costs were substituted with one, easy to control, cost line;
- 3) controlling and administration function were to be reduced.

Unfortunately results were far below the expectations. Not only qualitative parameters failed to catch up with a contract's provisions but Polish branch discovered that instead of cost reduction it recorded an increase eating into margins. Costs in fact skyrocketed, however not exactly in logistic areas. The total bill (sum of all invoices) from Swift Logistics for 2015 amounted to 3,6M PLN, but only 2,9M PLN referred to deliveries. The latter sum, compared to roughly 2M PLN of annual warehouse operating costs plus upstream and downstream did not look especially bad. The real cost problem seemed to laid in VAS which apparently costed an exorbitant amount of 0,7M PLN. These value was especially difficult to challenge in negotiations with the Contractor albeit non-homogenous nature of these activities. In addition a comparison to the previous scenario was complicated by the fact of using regular employees to perform them if other duties allowed for such solution.

## 2.3. Problem identification

Primary review reviled several additional facts. It turned out that CoGS of all products was incremented by 12% to compensate for costs of the Frankfurt warehouse. This represented, in case of Poland, an increase of 0,8M annually, still below 2M incurred in own unit previously but hardly to be neglected in calculations.

Both Management Board in Poland and HQ agreed that the situation required thorough analyses and issue of costs was absolutely essential. It was clear that a puristic approaches: full centralization combined with outsourcing and return to the previous arrangement with own warehouse represented only part of the options at hand. The challenge was to properly identify value created in each activity in relation to their costs in several scenarios in order to find the optimal combination. The only feasible approach was the one based on ABC. Each of the supply chain components had to be analysed in two dimensions:

- 1) as a separate activity;
- 2) in conjunction with other, related processes.

In addition qualitative and quantitative factors had to be considered as not all parameters could be meaningfully translated into monetary units.

## 3. ABC analyses

## 3.1. Assumptions

At first the calculation model had to address a set of predefined alternative scenarios. Two of them came natural:

- 1) the **current** one based on full outsourcing to Swift Logistics;
- 2) the **previous** one in house warehouse combined with external transportation.

Other ones had to be generated based on solutions available on the market. These encompass, among other the one based on a combination of outsourced warehousing, but in Poland, & outsourced transportation. It was labelled as "**local**" for convenience.

An appropriate calculation model had to reflect a defined set of activities in each scenario in consideration. It was easy to establish that the following ones had to be included:

- 1) deliveries to final customers (downstream);
- 2) outbound;
- 3) stocking;
- 4) inbound;
- 5) deliveries to warehouse (upstream).

But in course of discussion it quickly become clear that the process of utmost importance was the one hardly linked to logistics at first glance: so called value added services (VAS). Under these capture an array of activities related to conversion of selected articles, which came actually as components, into final goods fell. For example for various reasons wizards flying on brushes came in two parts: wizards themselves from China while brushes from Portugal and had to be assembled in warehouse. But a constant flow of such operations was a minor part. The bulk of orders was coming from marketing and sales as a result of various promotional efforts: bounded sales, Christmas actions etc. Near all of the included creating complete sets of toys in various configurations and in specially designed, colourful and otherwise attractive packaging. These were hardly managed activities as they appear quite incidentally as an outcome of successful negotiations with big retailers or specialized chains. Consequently VAS got included as an additional activity.

The relevant model had to consider an array of important parameters shaping effectivity of logistics operations from point of view of Super Toys in Poland. The leading one was certainly a total, annual cost of above defined activities. It had to consider not only OPEX but, as scenarios varied in a necessary inventory also a NWC capital has to be considered.

Application of the ABC method requires development of cost drivers for each activity. This task was complicated by use of various packaging modes both for upstream and downstream. Toy are not bulk commodity and vary significantly in shape and weight. Completion of deliveries in this business is still more an art than solving optimizing equitation. In upstream sometimes it was difficult to complete a full container for delivery so individual pallets got used. In downstream many deliveries were made in packages (parcels) with different standards. Finally it was agreed to use, for calculation purposes, a standardized conversion table presented Table 1.

Table 1.	Packaging	conversion	n units

Unit one	Unit two	Unit three	
1 container =	10 pallets =	60 parcels	

Source: Own assumptions based on <u>http://www.euro-shipping.com.pl/?page\_id=16</u> (access: 113.04.2017) but modified

Then it was decided to use a parcel as a cost driver for each activity except for VAS, in which case labour hours was the only option (see Table 2).

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Activity	Cost driver	Remarks
Upstream	Parcel delivered to a warehouse	It is relatively easy to negotiate one rate for each of two routes used.
Inbound	Parcel delivered to a warehouse	
Storage	Parcel stored	It would be more appropriate to use pallets however applying a consistent packaging unit across almost all activities was very convenient.
Outbound	Parcel delivered from a warehouse	It was assumed that the volumes of incoming outgoing parcels were equal. In practice some differences always appear but they rarely can and are planned.
VAS	Labour hours	
Downstream	Parcel delivered from a warehouse	In case of a regular flow of deliveries to a stable pattern of points negotiating a single rate saves administration costs.

Source: Own assumptions based on discussions with "Super Toys" management

Data were obtained from the following sources:

- 1) For the current scenario the Swift Logistic price list was used.
- 2) For the previous scenario existing records of then incurred costs were used but key items were updated via appropriate research.
- 3) For the local scenario some data derived from other ones could be used but it was necessary to run a tendering procedure to identify proper costs.

## 3.2. Calculating model

The calculating model based on the above outlined assumptions had to reflect not only ABC method but also different nature of costs in various scenarios. In scenarios I and III suppliers offers were a predominant source of information. 2015 results served as a base (see Table 3). They also served as Scenario I description. For the sake of comparability other two Scenario considered the same external parameters and key logistic volumes, for example number of deliveries, packaging structure, etc.

2015 results		Big retailers	Specialized	Petrol	Total
			shops	stations	
		н	S	В	
Deliveries					
Pallets	units	350,0	5,0	50,0	405,0
Parcels	units	2 000,0	3 500,0	1 000,0	6 500,0
Revenues					
Pallets	('000 PLN)	3 500,0	75,0	500,0	4 075,0
Parcels	('000 PLN)	2 000,0	5 600,0	1 000,0	8 600,0
Total	('000 PLN)	5 500,0	5 675,0	1 500,0	12 675,0
CoGS		0,7	0,5	0,6	
Pallets	('000 PLN)	2 450,0	37,5	300,0	2 787,50
Parcels	('000 PLN)	1 400,0	2 800,0	600,0	4 800,0
Total	('000 PLN)	3 850,0	2 837,5	900,0	7 587,5
I level Margin					
Pallets	('000 PLN)	1 050,0	37,5	200,0	1 287,5
Parcels	('000 PLN)	600,0	2 800,0	400,0	3 800,0
Total	('000 PLN)	1 650,0	2 837,5	600,0	5 087,5
Total relative to sales	%	30,0%	50,0%	40,0%	40,1%
Logistic costs					
Pallets	('000 PLN)	147,0	2,1	21,0	170,1
Parcels	('000 PLN)	840,0	1 470,0	420,0	2 730,0
VAS	('000 PLN)	420,0	-	252,0	672,0
Total	('000 PLN)	1 407,0	1 472,1	693,0	3 572,1
VAS workload	hrs	5 000,0		3 000,0	8 000,0
1 EUR =	4,2	PLN			
II level Margin					
Pallets	('000 PLN)	903,0	35,4	179,0	1 117,4
Parcels	('000 PLN)	- 240,0	1 330,0	- 20,0	1 070,0
VAS	('000 PLN)	- 420,0	-	- 252,0	- 672,0
Penalties (revenue)	('000 PLN)		14,8		14,8
Total	('000 PLN)	243,0	1 380,2	- 93,0	1 530,2
Total relative to sales	%	4,4%	24,3%	-6,2%	12,1%
Penalty calculations					
Number of parcels			565,2		
Indicator			0,25		
SMGA costs					2 000,0
Gross result					- 469,8

## Table 3. 2015 Super Toys financial results in Poland - Scenario I

Source: "Super Toys" managerial accounts modified

After a discussion a difference in NWC (in practice in inventory) was neglected. It was hard to estimate as it became clear that comparison of 2014 inventory in all European warehouses to the total in Frankfurt of 2015 showed only minor improvement (10% on average). At 10% WACC the corresponding increase in Poland would not exceed 20k PLN of costs.

On top of the data given above it was identified that Cost of Good solved included 813k PLN of central warehousing costs (12% mark-up).

## 3.3. Results

As indicated in p. 3.1 three scenarios got analysed: current, previous and local. Although they were meant as fully alternative for being based on different process setups certain differences had to be recognized and considered appropriately. As a starting point the current scenario was chosen and, since all calculations were based on 2015 flows actual 2015 results could be adopted as valid for this option.

As far as previous scenario was concerned the previously unified warehousing costs had to be broken amongst inbound, storage, outbound and VAS turning results shown below (Table 4). The most significant finding was that storage costs reflected idle capacity. Area of building surpassed by far what was really needed.

In case of the local scenario calculations were straightforward since bidders provided input data according to the ABC methodology.

2016 simulation		Big retailers	Specialized	Petrol	Total
			shops	stations	
		Н	S	В	
Inbound transport	('000 PLN)	203,7	175,4	64,6	443,7
Inbound	('000 PLN)	58,9	50,7	18,7	128,3
Storage	('000 PLN)	633,7	545,6	200,9	1 380,3
Outbound	('000 PLN)	88,9	76,5	28,2	193,6
VAS	('000 PLN)	107,2	-	64,3	171,6
Outbound transport	('000 PLN)	150,0	141,0	50,0	341,0
Total	('000 PLN)	1 242,5	989,3	426,7	2 658,6
Margins & profit					
		Н	S	В	0
I level Margin	('000 PLN)	1 650,0	2 837,5	600,0	5 087,5
Logistic costs - own w	('000 PLN)	1 242,5	989,3	426,7	2 658,6
Logistic costs - operat	('000 PLN)	1 407,0	1 472,1	693,0	3 572,1
II level Margin:					
scenario with own					
warehouse	('000 PLN)	407,5	1 848,2	173,3	2 429,0
scenario with an external operator	('000 PLN)	243,0	1 365,4	- 93,0	1 515,4
scenario with own	( ,	,.	/	, -	,
warehouse	%	7,4%	32,6%	11,6%	19,2%
scenario with an		·	ŕ		
external operator	%	4,4%	24,3%	-6,2%	12,1%
SMGA costs					2000
Gross result					
scenario with own warehouse	('000 PLN)				429,0
scenario with an external operator	('000 PLN)				- 484,6

**Table 4.** Total annual logistic costs in k PLN – the previous scenario

Source: Own calculations based on Clients' data, modified

Activity based costing as a tool for effective use of outsourcing in supply chain management – case study *Piotr Cyplik, Robert Uberman* 

Final results of annual logistic costs for each of three scenarios in consideration are demonstrated below (Table 5, Figure 1).

Scenario		Ι	II	III
Activity	Cost driver	Current	Previous	Local
		full outsourcing on European level	own local warehouse + external transportation	third party local warehouse + external transportation
Upstream	parcels	included in storage	444	444
Inbound	parcels	included in storage	128	83
Storage	parcel places/month	813	1 380	151
Outbound	parcels	included in storage	194	213
VAS	hrs	672	172	120
Downstream	parcels	2 900	341	341
Total		4 385	2 659	1 352

Table 5. Comparison of total annual logistic costs in k PLN

Source: Own calculations resulting from previous tables except for the local scenario.

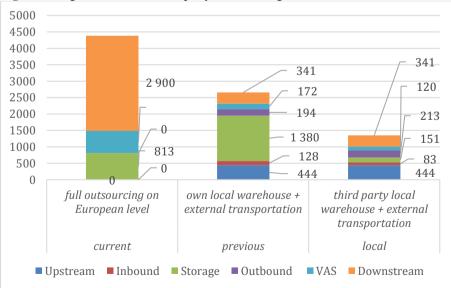


Figure 1. Logistic costs in k PLN per year according to each scenario

Source: Own calculations

Results obtained allowed for a profound analyses of all activities in consideration, margining influence of prejudices and particular interests of various corporate units. The following became obvious:

- 1) Transferring labour intensive VAS operations to a country with very high salaries was a clear mistake. It was caused by underestimating their value and volatility. Moreover it was determined in discussion that these activities require direct supervision from marketing staff to control quality.
- 2) Previous local warehouse so too big given the size of operations. The reason was that several years earlier HQ had a plan to use it for backing operations in FSU countries and requested Polish unit to assure additional space. The plan was abandoned but the rental agreement for a building stayed. This strongly impacted the storage cost level.
- After adjusting storage for real needs (Scenario III) and using an outsourced capacity rather than own warehouse it turned out that local solution was only 10% more expensive on total of upstream, inbound, storage and outbound – a difference savings on downstream and VAS would with no doubts compensate.

## 4. A COMPLEMENTING QUALITATIVE ANALYSES

In parallel to the above outlined ABC costing qualitative factors had to be considered. The diagnosis part of virus analysis of the logistics system was used. The logistics system virus analysis is a method to identify and analyse the reasons for various problems. The final result of this method is to elaborate a logistics system problem virus. To illustrate the problems one applied the medicine-based logic. The virus, which affects healthy tissues (system elements), make them die or be transformed into hybrids. In turn, the hybrids do not achieve the system aims. "Sick" tissues cause disturbances in the system functioning. The key to eliminate the system virus (including the reasons for source problems) is its unambiguous identification. The elimination process is performed by dedicated improvement actions or at least by limiting the virus action range. This results in an improvement of the system functioning method. The methodology of the diagnosis part of distribution logistics system virus analysis provides the following 6 stages (Cyplik & Hadas 2011):

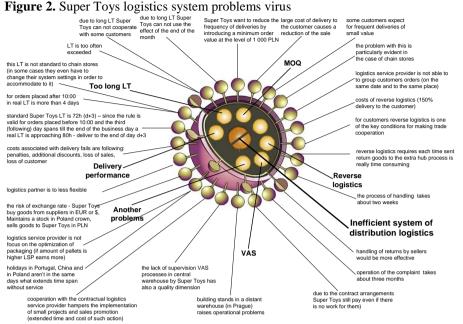
- 1) Determining the system objective.
- 2) Designating an expert group.
- 3) Problem identification.
- 4) Statistical analysis of the identified problem.
- 5) Present state analysis (AS-IS).
- 6) Elaborating the production-logistic system virus

Based on an analysis of the current condition, the team of experts compared to the existing state to the current trends in the market. One of the important aspects of functioning of logistics in the area of customer service is ensuring completeness and timeliness of deliveries. The research performed by the Institute of Logistics and

Warehousing (ILiM) indicated that completeness and timeliness of deliveries is one of the key indicators of evaluation of the logistical customer service. Competitive advantage can nowadays be gained by companies that maintain global standards in this area (aggregated OTIF index on the level of at least 95% or 98% in the FMCG sector). Another important logistics parameter in consideration was the lead time of deliveries, which in the recent years has definitely been reduced (according to the ILiM's research, in the case of European suppliers, the average time of order fulfilment is approx. 3.5 days, while in the FMCG sector a much shorter time is expected, i.e. not more than 48 hours. The delivery lead time proposed by Super Toys. (calculated as the time from the moment an order is places until the delivery is received) was equal to the average (nominally 96 h, in reality 80 h); however, sometimes it is exceeded. The order fulfilment times expected by customers depend on the individual agreements between the suppliers and the customers. However, an observation of the market leads to the conclusion that this time tends to be shorter and that the customers' expectations are changing to 48 hours; this is the challenge that Super Toys. will have to meet. Companies have different concepts of complaints handling. According to one concept, the customer should contact a designated representative of the company who has provided service to the customer (most often a representative of the sales department); in the complaints-handling process, such a representative forwards the complaint to be considered by appropriate persons responsible for that process. In another concept, the complaints-handling process is fully (start to end) performed by the complaints department (person). In the case in question it is thus less important who is responsible for the process itself. What is more important is the fact that the limitations in the logistics process of Super Toys. lead to additional costs associated with additional discounts and penalties for failure to meet the logistics conditions. Such costs should be charged to the owner of the process, i.e. the logistics operator. For this purpose, the level of untimely and incomplete deliveries must be monitored. Contemporary businesses perform their logistics processes more dynamically than in the past. A general contemporary trend in the market is the effort to increase the frequency of deliveries, with simultaneous reduction of the size of individual deliveries. This trend is created by, e.g. large distribution networks that expect logistics services that conform to their specified parameters. Customers, too, highly value provision of additional services by the suppliers, e.g. packaging of products in conformance to strict requirements specified by the customers. Such operations are becoming more and more important and constitute an important source of companies' revenues.

A comparison of the problems identified by the Project Team of Super Toys (Expert Group). with the above opinions of experts makes it possible to draw an image of the virus of ineffective distribution logistics system of Super Toys., as shown in Figure 2.

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#### Source: (com. Cyplik & Hadas, 2015, p.315)

In conclusion, the main problems in the ineffective distribution logistics system of Super Toys include:

- in the "delivery performance" area:
  - flexibility of the logistics partner;
  - costs related to incomplete deliveries, which reduce the profit margins;
  - frequent delays in deliveries;
- in the "lead time" area:
  - potential loss of customers if the average lead time level is maintained;

- lack of possibility to take advantage of the end of month effect (compared to the competitors);

• in the "MOQ" area:

- the need to revise the size and frequency of deliveries in order to determine the new values of applicable standards that match the needs of the market;

- estimation of the share of the distribution logistics cost (downstream of the chain of delivery) with smaller customer orders;

- in the "reverse logistics" area:
  - the customer complaint response time;
  - the responsibility of Super Toys for the complaint process;
  - the length of the complaint-handling process;
- in the "VAS" area:

- lack of control over the process of performance of additional services;

- limited manageable of the VAS in the Central Warehouse;

- lack of possibility to optimize the design of the stands in the context of reduction of their assembly time to a minimum.

## 5. CONCLUSION

The above presented case and calculation model offer several insights in applicability of ABC costing to evaluate outsourcing decisions.

Firstly ABC costing must be based on an adequate definition of scope of analyses followed by process identification. It is beyond discussion that there are no two the same organizations save industries. Certain patterns and terminology, however useful shall be used only as frameworks to start a discussion (Coopers & Kaplan, 2000, pp. 141-144). Set of activities called VAS may be defined as belonging to manufacturing, marketing, sales, etc. depending on approach and goal of analyses. But in the case discussed it was obvious that they had to be treated as a part of logistic operation.

The second issue refers to cost drivers. They play a double role. Primary they make pivots via which costs are allocated to different objects (activities, customers, etc.) (Miller, 2000, p. 44). Secondly they often are deemed to reflect cost determinants. Some authors differentiate cost drivers from activity drivers (Miller, 2000, pp. 44-48) but such differentiation is rare (Cooper & Kaplan, 2000, p. 127-133). Scientists typically stress a need for careful identification of cost drivers with special attention to information value versus measurement cost balance. But the practical experience, among others exemplified by the case in discussion, proves that a proper interpretation of their meaning and appropriate use for given decision making is much more important. Here comes the issue of idle capacity & orphaned costs. Sometimes it's ineffective to utilize resources in full. One can imagine allocating storage capacity on daily basis. However it would require an existence of ideally elastic warehouse with all costs equally elastic (or existence of another user with precisely mirroring needs). But in case of underutilization, orphaned costs have to be spread over active targets.

In many cases this two dimensional approach is right. Actually current management trends aim, maybe unintentionally, at unification of the two roles in consideration. Structuring contracts in the simplest and easy manageable way often leads to enhance this link. What adds to this trend is a desire to convert the biggest possible part of the cost into variable ones. On a theoretical level having easy to manage variable cost instead of complicated, dominantly fixed cost base is advantageous. But in many cases one has to be careful. Costs do not disappear as from a value chain albeit contracts signed. They just change an owner. It's always worth to run a comparable analyses of outsourcers' and own cost base in order to verify whether the former has really an advantage or is just taking the same risk aboard and charging fee for that. This typically does not require nor in depth knowledge neither access to restricted data. A common sense was enough to identify that VAS cannot be less expensive near Frankfurt than near Lodz (Poland). If any accounting system says the opposite the system itself requires analyses. Also a common sense supplemented by general knowledge would be enough to identify that the Polish unit would have to

be charged, directly or indirectly, for the central warehouse services. This omission must have been significant.

Thirdly one shall be careful in interpretation of ABC costing results. The nature of this methods require breaking company performance into separate activities. However useful such detailed view might appear one cannot forget that a company represents certain complex set of interrelations of which only a part can be quantified directly. Therefore, once making an outsourcing decision, unquantified factors have to be considered and somehow weighted.

Fourthly ABC costing is a fully quantitative method. Thus factors which cannot be meaningfully expressed in numbers must be considered outside the model and final decision shall always be based on managerial judgement. The process of it's development shall be organized around an applicable intellectual model – the virus presented in p. 4 being very good example of.

Decision makers, if aware of the above indicated deficiencies, shall apply ABC costing in various stages of outsourcing decisions: starting the process, selecting partner(s) and evaluating results. Only ABC can deliver on one side such detailed but on the another easy comparable information, creating unrivalled platform for efficient decision.

#### 6. ACKNOWLEDGEMENT

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## PROCESS APPROACH TO SUPPLIES AND ORDERS IN A PUBLIC HIGHER EDUCATION INSTITUTION

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#### Abstract

The article presents a concept of a process approach to the supplies of goods and services in a public higher education institution. The presented processes include also the internal orders and the external ones. The supplies are implemented in line with the public procurement law. It introduces a limitation for the proceeding which follows the ISO 9001 norm. The presented divagations are a development of the basic concept based on a pure process approach which has been implemented for a few years in public higher education institutions. After the first experience the concept evolved into a new one due to the necessity to aggregate the orders and a reluctance to single source procurement procedure.

Key words: process approach, quality management, supplies processes

## **1. INTRODUCTION**

Public organizations in Poland have a functional approach to management. Public higher education institutions are also in the majority of cases oriented on the management in the functional approach which leads to a situation when the achievements of the modern management and the advantages of a system approach to the permanent improvement of the organization are not available for them. In the functional approach the employees are highly specialized within their duties and they concentrate on their function and not on an efficient and effective implementation of processes which bring an added value for the organization (Wiśniewski & Mnich, 2016, p. 432). Such an approach facilitates the planning and supervision of the implementation and facilitates the cost calculation in the place where it is made. The employees specialize in the tasks and responsibilities which were given to them. The organizational discipline enforces a vertical communication maintaining the official procedure (Wiśniewski, 2015, p.42). The functional orientation impedes the total optimization, lengthens the time of the realization of tasks, increases the costs and decreases the flexibility of operation. The process orientation in which the single Zbigniew Wisniewski, Joanna Mnich

participants, implementers are responsible for the effect of the executed work rather than for executing it is in the opposition to the functional approach.

The article presents the results of the mapping of the supply process in one of the selected universities. The main research problem can be defined as follows: what are the main problems related to applying public procurement law in a public higher education institution? The purpose of the discussion is to analyze the way supply system works in a public higher education institution and to try to improve the The identification of the system irregularities is the basis for the procedures. improvement. One can hypothesize: the application of public procurement law is the most important principle in public higher education institutions and excludes the possibility of applying qualification procedures for suppliers based on quality management system. The research was conducted in the form of a case study at one of the largest public higher education institutions in Poland. The obtained results can be extrapolated to other public HEIs in Poland as they operate on the basis of the same mandatory regulations. The university had a defined aim: to prepare a process description in such a way as to identify the structure of the processes which take place and to optimize them. While mapping, the process of the supply of goods and services was identified. Thanks to a process approach, which is the main aim of the activities in this university, it was possible to obtain effects which could not be achieved in a traditional, functional approach.

The first iteration of the process approach to supplies in this university was created in a non-optimized configuration. Its aim was to reveal a real structure of the realization of tasks (Wiśniewski & Mnich, 2016, p.432). The current iteration can lead to an improvement of the process. An excessive allocation of the purchase tasks in the units of the organization instead of concentrating them on the central level was one of the disadvantages of the presented process. The supply process did not benefit enough from the scale effect.

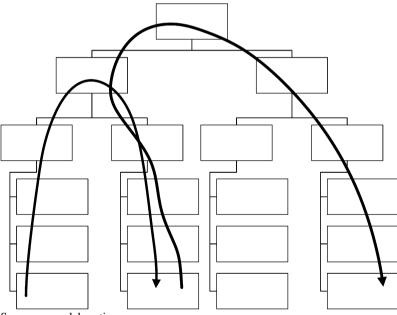
#### 2. PROCESS APPROACH

In the organizations with a functional approach there is a high level of bureaucracy, considerable problems with coordinating the activities around common aims since the knowledge on the functioning of the organization as the whole one and its parts is dispersed. It is dispersed among the specialists of the different areas. Many units or even many departments are implemented in the given process. The coordination of the activities is tedious since there are the rules of communication which require the acceptance of the direct superiors. None of the employees is responsible for the sequence of activities but only for the fragment which is attributed to them. It is almost impossible to react in a flexible way to the changing needs of the environment and the needs of other units within a given organization. However, the worst is the fact that the decisions are not taken in the place where the problem appeared because in this kind of organization there is a clear division between the decision makers and the executors (Figure 1).

Such a style of management was highly effective in the times of the intense development of the production structures based on the criterion of technical and economic efficiency. Nowadays it is not beneficial at all when the new challenges are created which make it necessary to react quickly to the changing expectations of every stakeholder in order to satisfy the needs for which the given organization was created (Muhlemann et al., 2001; Kisielnicki, 2008; Wiśniewski, 2010).

It leads to a situation when none of the units and none of the employees have a need (resulting directly from their role in the organization) to identify their work and duties in the reference to the product or a service offered to the clients on the market. The employees do not distinguish from the whole the range of the executed tasks for which they are responsible and provide it to the further processing in other working positions. In the functional organizations the thinking in terms of the functions leads to optimizing activities of the parts to the detriments of the totality and absorbs the energy of the company for the coordination of the divided parts.

**Figure 1.** Official procedure of taking the decisions and solving problems – a distribution channel and a channel of taking the decisions goes through the supervisors of both stakeholders



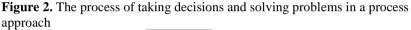
Source: own elaboration

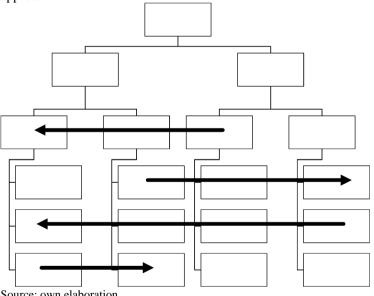
The processes are artificially divided by the borders of the units and the vertical division of work is in favor of the division into commanders and executors which separates the thinking from the execution.

The information flow is long (Figure 1) and the decisions are taken in the places where the activities are conducted (Bitkowska, 2009).

The form of the cooperation and the communication between the positions and the processes is an important issue which is the obstacle in the effective usage of the potential of the organization. If the employee is accounted for the work which is done and not for the process of making it, then the obtained effect is important. Therefore instead of not reacting to the wrongly prepared input stream to the process (as is the case in the functional structures) such as wrongly prepared documents, badly processed material, wrongly configured software which result in the work which is not done, the employee can take an initiative to submit a complaint to their supplier. Every stakeholder which executes work is a client for their supplier. The work cannot be done well if the supplier does not provide a source of a good quality for the entrance to the process. In order to make such a mechanism work, an employee must know the link between their process and the others: suppliers and clients. They will address the first group - the suppliers- when the raw materials of an improper quality is delivered and the second ones can be addressed in order to satisfy their needs in a proper way.

Such a self-regulating system is the best solution which guarantees an adjustment of the single processes in the organization on the basis of the quality balancing and ensuring the quality of the single processes.





Source: own elaboration

The thinking in the category of processes means a perception of the organizational system as a system in which the places and the roles are variable and defined by the activities (operations) which must be conducted in order to create a value expected by a client. This way of thinking helps to identify an own role in the strategic operation of the whole company and places an employee within the activities of the whole group and not within a closed space which specializes in the implementation of the homogenous tasks of the unit. It facilitates the understanding and a verification of the sense of own work taking into consideration its usefulness

for the client and not only the evaluations of the superior as the substitute of the client. It is also in favor of the adjustment changes by supporting the members of the organization in gathering the resources of knowledge and learning which can become a very important element of the competitive advantage (Bitkowska, 2009).

The process approach puts the emphasis of translating the strategic aims of the organization into the aims of processes, the satisfaction of the clients' needs, the decrease of the costs of company's operation as well as on the increase of the quality and shortening the time of the realization of the tasks. The place and the role of employees are variable and defined by the processes which must be executed in order to create a value which fulfils the clients' expectations. The employee is situated within the activities of the whole organizations and not in the closed, specialized space to implement the homogeneous tasks of the unit. The decision-making power is transferred to the place where the activities are done and the information flow is shortened (Figure 2).

Each process in the process organization is verified by the level of the values assessed by the client, contrary to the functional organization where the measure refers to the level of the realization of the tasks and is evaluated by the responsible managers.

Despite the advantages of the process approach over the functional management, it is not always easy to implement it in an efficient and an effective way. The attachment to the traditional way of management and a fear of change are the obstacle. In case of the public organizations, the resistance is even greater. This results from the fact that in such organizations which do not operate for the profit, it is difficult to define a role of employees for the success of the company.

The more so that the success is not measured with the size of the profit, the brand recognition or the level of the clients' lovalty. The public organizations are in the majority of cases monopolists on a given market and that is why they do not need to attract the attention of the potential clients. It is slightly different on the market of the educational services, particularly on the level of the higher education. There is a greater competition which results in a necessity to try to attract the attention of the clients- the students. There is a growing interest among university managers for a modern management approach. For them, the chain of value creation and the interrelation of elementary activities performed by staff with customer satisfaction are important. The higher education institutions have one more element which really strongly "protects" them against the usage of the modern approach. It is an "academic tradition". It is a collection of customs, rituals and even a management style which derive from a long tradition of universities. The universities have worked out during the dozens of years or even during the centuries based on approach attached to certain behavior which defines the identity of the institution. That explains the reluctance to implement new elements and what led to ineffective management. (Bogdanienko & Piotrowski, 2013; Morawski et al., 2010).

Many universities understand the burden of the academic tradition, face the challenges of the reality and try to operate in such a way to ensure a dynamic development. The application of the process approach is a very important element of challenge.

The article describes a situation of one of the biggest Polish higher education institutions in which the management is convinced about a necessity to boost the activities, increase a flexibility, improve the internal flows, facilitate the building of relations with stakeholders and that is why it decides to gradually implement a process approach due to a desire to implement a system of the quality assurance (Piasecka, 2011). The very idea of the implementation of the system proves that the authorities understand the role of the organization in the business environment.

# **3. PROBLEM OF PROCUREMENT IN A PUBLIC HIGHER EDUCATION INSTITUTION**

The public higher education institutions are the organizations in which it is very difficult to implement a quality management system which is in line with the norm ISO9001 which prefers a process approach. However, the application of the particular requirements of the above-mentioned norms could improve the functioning of the organization in many operation. In case of some processes the effectiveness of the functioning of the organization greatly depends on a good relations with the external partners. It is the case with the requirements which refer to purchase preferably to the so-called "strategic purchases" which are important for the university key processes – education and research.

In many higher education institutions, the internal units have a great deal of autonomy, including in the financial area. This means that the management of these units allocates financial resources at their discretion. This autonomy leads to the reluctance of managers to give the right to choose suppliers of goods and services of central administration. If goods and services were ordered globally for the entire university, then unit costs would be lower. The consequence is that the university as a whole suffers losses Wiśniewski & Mnich, 2016). The centralization of the purchase done within the higher education institution on a central and departmental level would give visible financial advantages and shorten supply chain eliminating the repeatable processes within the same organization. However, this approach often meets the resistance and the barrier in the form of the objection of people on the different levels of the management. The reasons for this situation can be found in a wrong conviction that the centralization of the purchase process in one place (unit) would significantly decrease the autonomy of the basic organizational units depriving them of a possibility to decide about the kinds, amount of purchase and the choice of the suppliers. The managers of the single internal units play the managerial roles due to their great achievements in the field of a given scientific areas. The competencies due to which they are the managers are not in line with the competencies which are required from the managers and what, besides others, generate excessive costs of the functioning of the companies.

It is important for the authorities of the universities to be able to identify the groups of the goods and services important due to their share in the value of the whole structure of the purchase and make the organizational units conduct the purchase on the central level. It is very important for university authorities to identify the groups of major goods and services due to their highest costs of purchase and to make the units of the university purchase at the central level.

The procurement process in a public higher education institution is multi-level and multi-stage. It combines purchases for the levels of the central administration (rector and chancellor administration) and for all other organizational units (departments, institutes, colleges and so on). This causes many problems because the central administration of the higher education institution buys independently of the purchases made by the organizational units. The implementation of management decentralization of the higher education institutions in the 90s caused the situation when the university became a federation of the departments. They operate autonomously but in the reality they do not have the full independence. The strategic decisions are taken by the central authorities. The decisions referring to the staff management and the financial issues greatly fall within the responsibility of the central offices. That is why managers of the single units (departments, institutes, chairs) want to maintain their autonomy in the purchase of the goods and services. This leads to an increase of costs which was mentioned above. Each unit buys a big number of stationary, equipment and computer services, software, pieces of furniture, insurance services, cleaning services, protection services, laboratory equipment and chemical reagents, construction services and so on. The purchase are conducted separately for every unit. The managers of the units defend their autonomy in carrying out their purchases and therefore do not wish to pursue the concept of collective purchasing. This causes considerable shortcomings despite the introduction of a process approach to shopping (Mnich & Wiśniewski, 2016).

# 4. IMPLEMENTATION OF THE PROCUREMENT PROCESS IN THE PUBLIC HIGHER EDUCATION

The considerations listed below are based on the solutions used in a big public higher education institution. This organization, using a process approach in the management, did a mapping of the processes which function within it. According to the rules of the process approach, three main groups of the processes were distinguished within the organization: the managerial ones, the main ones and the supporting ones (Mnich & Wiśniewski, 2016). In the group of the supporting processes, next to the process of the management of human resources, infrastructure, finances, there was also a process of supply of goods and services. The need to ensure a continuity of the delivery of materials and services necessary to implement the main processes at the higher education institution is a basis of the process. The process of the purchase is done in parallel by the units of the central administration and the selected services in the basic organizational units. Looking at it by the prisms of the organizational scheme of the higher education institution, in the process of supply are engaged in parallel: the units which are placed in the chancellor administration (the unit of supply and public procurement) and people who are appointed to do so in every basic organizational unit.

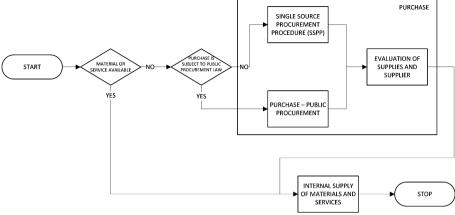


Figure 3. The process of supply of materials and services

Source: Wiśniewski & Mnich, 2016

The unit of supply which functions within the chancellor administration ensures the purchase of goods for the rector administration and to a small extent for the basic organizational units. The central process of purchase presented in Figure 3 takes place in two ways and is conditioned by availability of a needed material or a service in a given moment. This solution is a good solution and allows to implement correctly the processes of the purchase of goods and services. The central administration serves all the departments of the university. Thanks to it, it is possible to implement a coherent policy of ordering which includes almost 50% of the people employed in the higher education institution. Unfortunately the value of the purchases (besides the construction investment) constitutes only 25% of all the purchase of the university. The remaining 75% is done by the departments which have a separate purchase policy.

The purchasing process implemented in accordance with the guidelines of the quality management system is based on purchase information, commonly referred to as the "specification" and on the subsequent verification of the purchased goods. These elements are intended to facilitate the organization's implementation of a quality management policy that communicates the need to build mutually beneficial relationships with suppliers. If there is a need to buy the materials or services by the supply unit, it starts the procedure which can be twofold. If a given purchase falls under the requirement of the law on public procurement, than the procedure of the purchase will be conducted by the Public Procurement Unit. When there is no need to launch the procedure of the public procurement, the process is implemented according to the requirements imposed by the system of the quality management. The procedure presented in Figure 4 starts together with the choice of the suppliers from the qualifying list. These are the suppliers which are accepted for the cooperation on the basis of the qualifications and the positive evaluations of the current cooperation. This list is a dynamic one which is updated all the time on the basis of the current cooperation and includes simultaneously the previous cooperation. If a possibility of a purchase goes beyond the choice of the proper supplier from the qualified list, the process of the search for a proper supplier starts.

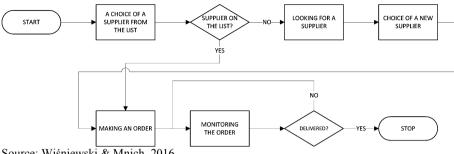
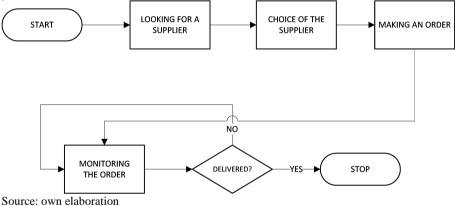


Figure 4. Process of the purchase using the single source procurement procedure

Initially, this approach to supply was implemented. Unfortunately this scheme had to be verified due to the fact that although the list of the suppliers who had a long history of the cooperation with the institution, there were the fears whether the usage of the suppliers from the list will not expose the decision makers to the accusation of omitting the rules of sound competition. That is why this scheme after a practical verification was simplified (Figure 5).

Figure 5. The verified process of the purchase using the single source procurement procedure

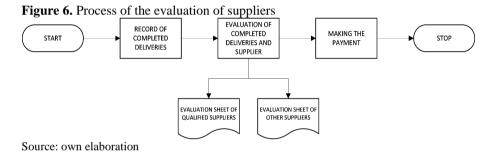


If it is possible, it is beneficial to have delivered a sample batch of goods, have them tested in the conditions of functioning or eventually to choose a given supplier only on the basis of the general widely available knowledge on him. The formal submission of the order in the right form (a letter, an e-mail, a fax, a telephone, others) defined earlier with a supplier is the activity which initiates the purchase. Since this moment the monitoring of the execution of the order starts which depending on the specificity of the purchase can take from a few days up to a few months. A passage to the next stage is dispersed in time and finishes the moment when the purchased good is delivered or a service delivered. It can be assumed that simultaneously it is the moment of the beginning of the process of evaluation of a supply and a supplier.

Source: Wiśniewski & Mnich, 2016

#### 5. EVALUATION OF SUPPLIERS

The supply of every purchased batch of goods is registered both for the accounting reasons and for a proper assessment. The evaluation of the correctness of the implemented service or a delivery should be based on the predefined, clear criteria. They should be measurable, the same for all the important features of the product or a supply as only then one can make an aggregated collective evaluation of the supplier. In the majority of cases the point evaluation is used according to the adopted scale e.g. from 0 to 5. This evaluation is the assessment of the delivered goods or a service but is also the evaluation of a given supplier. It is important to have a coherent system of the evaluation of supplies and suppliers which follows the same guidelines and enables the exchange of the information on evaluation in all the units of the higher education institution as only then it is possible to use the evaluations done by other participants of the process.



The process of the evaluation of the supply and the supplier presented in Figure 6 is conducted both for the purchases which are made on the basis of the public procurement and all the others done within the higher education institution. Despite the fact that the law on public procurement does not provide a possibility to use the evaluation of the previous cooperation while qualifying the suppliers, it is a good practice (despite everything) to evaluate systematically the suppliers and their supplies. This evaluation should be used and can be helpful for other internal units of the higher education institution which in a given moment can purchase the goods from a given supplier omitting the procedure of the public procurement.

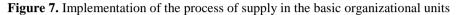
It must be noticed that the usage of the evaluation of suppliers for the choosing them for the second time is a breach of the Polish law. It is bizarre that while choosing a supplier of a service or of a good one cannot use the knowledge on the current cooperation since it is a violation of the rules of competitiveness. The interpretation of the provision is such that the bidder which has a history of cooperation with a given company would be treated differently than the others who compete in the tender. Therefore one cannot use the current knowledge on the cooperation regardless of the fact whether this knowledge speaks about a great fulfilment of the expectations so far or whether a given bidder was disgraced during the previous contracts. This troublesome for the quality of the development way of interpreting the provisions does not exclude completely the application of the knowledge of stakeholders. It is possible to include in the conditions of the call for tenders a requirement to deliver e.g. all the opinions on the cooperation with the clients from the last year. However, it is a difficult casus which can be applied.

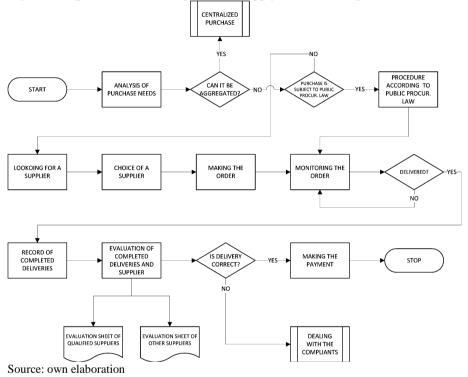
Despite these difficulties, the process of the evaluation of supplies which is at the same time the evaluation of suppliers is done in a parallel way in all the basic organizational units of the university which conduct the purchase process. The results of this evaluation are placed in the IT system which supports the management system. There are two different kinds of the evaluation sheets: the first group is used for the evaluation of the so called "qualified" suppliers, the second one for other suppliers. The evaluation forms are available in every organizational unit of the higher education institution for people who evaluate the supplies and allow at the same time to introduce the evaluations from the single supplies and delivered services and sum automatically the evaluations of the purchase done by the same provider. The evaluation which is permanently updated, available on the IT platform, allows for a current review of the evaluation by other units which also buy goods. This knowledge can and should serve the more cautious purchase decisions. Taking the decisions based on the facts is in reality the implementation of one of eight rules of management. Additionally, the permanent comparison of the processes of supply between the different organizational units of the same higher education institution can be another positive aspect of the transparency of the evaluations of supplies and suppliers. This internal benchmarking can and should lead to finding the most effective and the best solutions and coping them within the whole organization.

The usefulness of using the evaluation forms of suppliers and the whole knowledge on the proceeding which took place which is gathered refer mainly to the proceeding which are conducted outside of the law on public procurement but this constitutes a small part and due to the evaluation of the purchase towards the scheme presented in Figure 5 - the less and less common.

#### 6. IMPLEMENTATAION OF SUPPLIES IN THE UNITS OF HIGHER EDUCATION INSTITUTIONS OUTSIDE OF THE CENTRAL SYSTEM OF SUPPLIES

In single organizational units the purchase is done independently, parallel and analogically as in the central part. The implementation of the purchase by the basic organizational units is divided into: the purchase which does not require the application of the procedures connected with the law on public procurements and the supplies of goods and services which require the application of the procedures described in the law on public procurements, the detailed internal regulations and the regulations of the concerned unit. The scheme below (Figure 7) does not include the purchase done by the organizational unit in a different organizational unit of the same institution on the basis of the internal financial documentation. The first common stage is the analysis of the relevance of a given purchase. On the level of the units, in this place it is necessary to answer a question whether a given purchase will follow the procedure of the law on public procurements or can be done on the basis of single source procurement procedure. If a purchase is done on the basis of the procedure of the public procurement, another important issue is taking the decision whether the procedure is done within the very unit. If within the basic organizational unit there are no human resources able to conduct such a procedure according to the guidelines of the law on public procurements, the need for such a purchase is directed to the unit of public procurements which is a unit of the chancellor administration. If the procedure of the purchase is done within the unit, than the central unit only gets a plan of the purchase for the given time approved by the manager of the unit; it should be also approved centrally.





The purchase using the procedure of single source procurement procedure is conducted on the basis of the guidelines included in the system of management and include the usage of the qualified suppliers or the purchase from the new supplier to make the order. As it was mentioned earlier, in practice on the central level the list of suppliers from which the orders can be made again is not used. The fear of the failure to comply with the rules of the competitiveness causes that the rules similar to the ones imposed by the law are used. They are implemented in a simplified form. There is even a possibility to use partially the knowledge on the current cooperation, that is the evaluation form, but in a limited way.

Starting from the stage of the monitoring of the implementation of orders, the following activities include a record, an evaluation of the previous supplies and a

possible complaint procedure which is done jointly, regardless of the unit and the purchase procedure.

The scheme which is presented in Figure 7 is different from the model included in the original project presented by Wiśniewski and Mnich (2016). The difference comes from the elimination of the part of checking the availability of suppliers while acting outside of the law (just as is the case of the modification of Figure 5 in comparison to the original presented in Figure 4) and as well as from the duty to aggregate the purchases.

#### 7. CONCLUSIONS

An analysis of the way of functioning of supply services in a public higher education institution allows to draw the following conclusions.

The public procurement law forces higher education institutions to apply the principle of free competition, which means that all tenderers must have equal opportunities when choosing a supplier of goods or services.

If a supplier has previously cooperated with the higher education institution and failed to fulfil the contract, then in case of a re-selection, the higher education institution has no right to use that knowledge against them.

On the other hand if this institution has a quality management system implemented it is required to gather knowledge about how suppliers meet their obligations and, at the next selection of suppliers, to use this knowledge reasonably. The aim is to avoid unreliable suppliers. If the higher education institution does not centralize the supply, it further increases the risk that the dishonest supplier can sign again a contract with one of the university's internal units, because the knowledge of the bad history of collaboration is the knowledge accumulated in each unit separately.

The centralization of strategic purchases is the solution proposed on the basis of the divagations discussed here.

This results in the accumulation of knowledge on the reliability of suppliers in one place of higher education institution. The second step which is possible on the basis of a procedural approach, is to establish clearly exceptions to the application of public procurement law - in such cases the higher education institution can freely use the knowledge on existing partnerships with suppliers in the framework of the quality management system.

And finally, the third step is to apply the rule that each supplier must provide references from their recent contracts, including those made with the higher education institution. In this way, the university has the right to use the knowledge on the existing cooperation with a supplier who is re-applying for a contract.

The above principles make it possible, under Polish law, to apply the public procurement law using the knowledge gathered in the processes of the quality management system. This means that the hypothesis presented in the introduction of this paper is untrue as long as the system approach is followed, preferably based on a quality management system.

The presented concept of supply process and its sub processes in a public higher education institution boils down to the description of the reality in a process approach.

The presented map of the process shows all the possible variations of the supply process in such a complex environment. The identification of a real structure of the supply process and the knowledge on the methodology of optimization of processes give an opportunity to improve this aspect of the functioning.

Figure 7 presents this very important change which is supposed to make the managers of the single organizational unit check whether a given purchase is on the list of central purchase. This plan includes also the needs from the different organizational units and they are aggregated for the whole institution. It is valid to make the plan for a long period of time (one year). Then it becomes possible to use the effect of scale and to submit collective orders. This undermines the autonomy of the units but brings significant savings within the whole higher education institution. It turns out that in case of such orders as property insurance the sayings of 13% per year can be made and for cleaning services up to 7 %. This does not means that such an aggregation is obligatory and it must be always applied. The economic rationality sometimes involves the need to fragment the purchase. The insurance can be mentioned as an example. It is a common practice of the insurance companies to increase insurance premiums when in the previous period the payment of compensation was made (e.g. because of a threat, fire, flood and so on). In such a case, a small organizational unit such as a department should choose a purchase in a company in which so far no compensation was claimed. It turns out that in such a case the insurance purchased outside of the central system will be less expensive than if the scale effect was used when the situation is unfavorable for the units within the higher education institution. The optimization taking into account the economic criteria should always be the choice of the supplier. But not the only. The second example refers to security services. If every department purchases this service in a different company than on the junction of the protected areas there is no cooperation between the different protecting companies. In this case the supply of the service done in the complex way is more beneficial for the economic reasons.

The presented processes revealed many aspects of the supply in the higher education institution unknown before. The process approach made the managers of the higher education institution verify the current basis of the purchases. The very usage of the process identification allows to understand people who implement the tasks in this area what the relations between their work and the realization of tasks in the different positions are. The process approach made also the managers of higher education institutions verify the current basis of purchases. The aggregation gives a lot of saving so it is necessary to "deprive" the internal units of the university a part of autonomy in order to conduct centrally the strategic purchases. It is necessary to take into consideration the long-term economic situation which can show that just as it was the case with the insurance, that the diversification of supply can give more benefits than the centralization.

An analysis of the readiness of the public administration staff to adopt a new standard for selecting suppliers should be the next stage of research. The choice made using the current knowledge of suppliers is a very good option but higher education institutions managers have concerns about whether this approach is in line with the law of public procurement. According to the authors of the research the answer is yes, but the problem of failing to apply a solution lies in the long tradition of using classic solutions. Few public HEIs can be proud of implementing a process approach in management.

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## MULTIPLE CRITERIA EVALUATION OF SUPPLIERS IN COMPANY OPERATING IN CLOTHING INDUSTRY

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#### Abstract

The paper presents a coherent methodology of a multiple criteria evaluation of suppliers in clothing industry covering: definition of a set of variants – fabric suppliers, definition of a consistent family of criteria that allows for their comprehensive evaluation, modeling of decision maker's (DM's) preferences (including: the definition of the importance of criteria and the DM's sensitivity towards changes of criteria values), computational experiments resulting in the final ranking of suppliers and finally the selection of the most desired supplier.

The analysis of 5 suppliers namely fabric producers, operating on the Polish market, whose factories are located in Poland, have been taken into consideration. Also in the family of criteria evaluating the cooperating units (important for the DM), 9 measures have been taken into account. These have included, among others: product price/cost and payment conditions, timeliness of delivery/ supplier, reliability of delivery/ supplier, cost of delivery, accessibility of supplier. In the computational phase a selected MCDM/A ranking methods (especially Electre III/IV and AHP methods) have been applied.

**Key words:** Suppliers selection problem, Ranking of suppliers, Multiple Criteria Decision Making/ Aiding (MCDM/A), Electre III/IV method, AHP method

#### 1. INTRODUCTION

Each business entity carries out its own supply process regardless of one's operating industry. Companies purchase wide range of raw materials, components, semi-finished goods or final products. They are all necessary to conduct business activity, mainly for manufacturing or service companies. Supply process, which is a key component of one's successful functioning on the market, significantly affects not only company's economic situation but also its position regard to competitors.

The selection of the desirable supplier plays a key role in the whole procurement process. As it determines a future success of the company, it ought to be well-thought and based on the set of criteria relevant from the company's point of view. In terms of suppliers selection process, a number of methods can be applied, including multiple criteria evaluation methodology. The above mentioned method consists of the following procedures: defining the set of variants (e.g. suppliers), defining a consistent family of evaluation criteria, structuring of decision maker's preferences model in the given decision situation, carrying out computational experiments aiming at obtaining the final ranking and enabling the selection of the most desired variant. Conducting the effective process of selection may help to obtain fruitful cooperation between potential supplier and a parent company and may be a key factor of their future success.

The overall research goal of this paper is to present a universal, generic methodology of evaluating suppliers and selecting the most desirable ones regarding the considered business environments, supply conditions and external circumstances. The authors claim that the suppliers' selection problem has a multiple criteria character, and thus develop the proposed approach based on the principles of Multiple Criteria Decision Making/ Aiding. The challenge and the novelty of this work is to present the comparison of the multiple criteria evaluations of suppliers across the clothing industry, using the original methodology which is based on the previous authors' works and experience.

The hypothesis of this works indicates the way of evaluating and selecting the most desirable supplier, generating various possibilities based on the multiple criteria analysis.

The object of the research is the company operating in the clothing industry, which produces and distributes clothes for women, men and children. The company is a leading entity within others operating in East-Central Europe retail market. Its incoming collection will present clothes made of new quality of fabric with UV stabiliser. As so far the company has not purchased this kind of fabric, it has been decided to verify the potentiality of polish producers.

In terms of structure and methods used, the paper presents characteristics of 5 suppliers – manufacturers of fabric with UV stabiliser. The evaluation criteria (crucial from the company Board of Directors' perspective – acting as decision maker) include 9 main criteria and their sub-criteria which are, among others: quality of fabric, price, timeliness of shipments, safeguard supply (process) and supply flexibility. In terms of computational procedures multiple criteria ranking methods have been applied, including Electre III/IV and AHP.

#### 2. THE PROCESS OF EVALUATION AND SELECTION OF SUPPLIERS

#### 2.1. Nature of the Process

Cooperation with suppliers plays the crucial role in procurement management i.e. entities responsible for delivery of goods such as raw materials, components, semifinished goods or finished products required by the manufacturers, distributors or service providers. Cooperation with the suppliers is a key component, which determines the proper functioning of the company. What is more, the effective logistics which is providing a high standard of delivery performance as well as the lowest costs and high customer's satisfaction, nowadays are believed to be more significant than product's advertising process or the final price. The supplier aims above all to attain a high quality by participating in production and purchase process in the buyers company (Appelfeller & Buchholz, 2011, p. 71). Thus, the selection of the most desired supplier is one of the most important economic decision which determines existence and good functioning of the company. Also, operations relating to the receipt of goods, settling payments and delivery are not enough to guarantee a success. Discontinuity of supply may incur huge losses to the company i.e. loss of consumer confidence, reduction of orders, deterioration of company reputation and decline in market position (Kulińska, 2009, p. 24). Therefore, suppliers' selection is becoming a relevant factor in logistics chain of the parent company.

The selection of the desired supplier is crucial for the company since it provides for the short- and medium-term of the goods' protection. Thus, one has to create the structure of suppliers who are able to provide necessary products (Piontek, 1993, p. 103) regarding reliability and high quality of delivery performance as well as the competitive market price. The suppliers' final selection and evaluation is based on the multiple criteria methodology (thoroughly described in the next section of this paper), ensuring minimisation of the total purchase costs and maintenance of stocks. Other reasons for undertaking cooperation with suppliers are (Sudolska, 2008, p. 110-111):

- improvement of products' quality,
- increase of product assortment,
- relative flexibility in procurement,
- willingness to modernise existing technologies,
- ability to obtain modern technologies,
- continuity of deliveries in case of unexpected events,
- possibility to negotiate prices of the deliveries.

The selection of the suitable supplier is a really significant economic decision which will determine the future success of the buyer. Such decision ought to be carefully analysed and well-thought. It is also an example of multiple criteria decision problem, which means that the evaluation of the supplier should include both qualitative and quantitative criteria. Also, such approach allows to select the most desired supplier in order to guarantee a long-term, fruitful cooperation between purchaser and vendor.

#### 2.2. Suppliers Evaluation Criteria

In order to select the accurate supplier, number of different criteria, specifying company's expectations, need to be taken into consideration. Such criteria are defined with appliance of the following rules (Krawczyk, 2001, p. 333):

- the number of criteria ought to be reasonable, regarding the importance of the issue,
- criteria ought to be complementary, allowing for assessment of all necessary selection aspects,
- criteria should be applied separately in order to avoid repetition in evaluation process,
- criteria ought to be possible to arrange in terms of their meaning and value.

Regardless of the company's operating industry, one should evaluate the supplier considering the following aspects (Mukherjee, 2017, p. 66; Piontek, 1997, p. 178;

Piontek, 1994, p. 135-136; Lührs, 2010, p. 114; Easton et al., 2014, p. 39; Piontek, 1997, p. 178):

- product's price,
- quality and variety of the raw materials, components and semi-finished goods in offer,
- deliveries' conditions (including: supplier's location, reliability of the delivery, payment terms and conditions).

Depending on the specific character of each company, its operating industry or specification and relevance of one's procurement process, more detailed criteria (including higher number of criteria) can be applied in order to evaluate potential suppliers. It was originally described by Dickson (1966, p. 15-17), who carried out extensive research in 60s of 20th century indicating 23 relevant factors used by the companies in suppliers evaluation process. Considering the value of each criterion, he indicated as the most significant: price, quality and performance of the delivery. The other researcher Burton (1988, p. 38-41) introduced 10 criteria which are: quality, delivery, production facilities and capacity, net price, technical capability, packaging ability, geographic location, training aids, management and organization, operational controls. Other researchers tried to reduce number of factors i.e. Bernard (1989, p. 1-7), who described 5 attributes (quality, delivery, net price, management and organization, service) or Chapman (1989, p. 1993-2007), indicating only 3 criteria (quality, delivery, production facilities and capacity).

Different model presented by Yücenur, Vayvay and Demirel (2011, p. 823-833) indicates 4 supplier evaluation criteria (service quality, cost, risk factors, supplier's characteristics) and 28 attributes. However, Ordoobadi (2009, p. 314-327) also describes 4 criteria (quality, delivery, service, costs), but only 12 sub-criteria. What is more, exactly the same criteria are presented by Labib (2010, p. 6287-6299). Other authors: Ertay, Kahveci and Tabanli (2011, p. 1152-1167) indicate 6 main criteria (reliability, responsiveness, flexibility, cost and financial, assets and infrastructure, environment) and 20 sub-criteria.

Most recent publication of Galińska and Żak presents the model of the supplier evaluation process with an application of the following criteria (Żak & Galińska, 2017, p. 132):

- Product Price/Cost and Payment Conditions,
- Timeliness of Delivery/ Supplier,
- Reliability of Delivery/ Supplier,
- Cost of Delivery,
- Accessibility of Supplier,
- Customer Service Quality (during the supply process),
- Market Position of the Supplier,
- Performance of the Supplier,
- Modernity of the Supplier.

This article presents the case study of suppliers evaluation process based on the above mentioned criteria. All these aspects are thoroughly described in section 4, whereas the computational experiments, carried out with the application of these criteria, are presented in section 5 of this paper.

#### 2.3. Methodology in the Suppliers Evaluation and Selection Process

Suppliers evaluation considers one's ability to safeguard supply sources, develop a trustworthy relationship with the supplier, reliability and trustworthiness in their partnership, introduction of the clear selection process and maintenance of a sustainable advantage over competitors. Within the scope of procurement process, the final selection of the most desired supplier is the last stage of a decision process. It also forecasts the profits for the company from establishing cooperation with the potential supplier. Then, the parent company commissions the execution of some services to the counterparty. Finally, the results of supplier's evaluation criteria and their potential to build long-term cooperation with the customer should be taken into consideration in the whole selection process<sup>5</sup>.

In addition, evaluation and selection process can be carried out with an application of both qualitative and quantitative methods and procedures. The most common are (Figure 1):

Figure 1. Ranking of suppliers' evaluation and selection methods

qualitative method	<ul> <li>Knowledge-based system</li> <li>Brainstorming</li> <li>System based on the feedback about a supplier</li> <li>Scoring method+ pentagonal graph</li> <li>others</li> </ul>
quantative method	<ul> <li>Scoring method + pentagonal graph</li> <li>Pareto Rule / ABC Analysis</li> <li>CM Method (Catherogical Method)</li> <li>DEA Method (Data Envelopment Analysis Method)</li> <li>CA (Cluster Analysis)</li> <li>CBR Systems (Case-based-reasoning)</li> <li>MCDM (Multi Criteria Decision Methods)</li> <li>TCO Models (Total Cost of Ownership Models)</li> <li>Mathematical Programming Models</li> <li>Artifical Intelligence based models</li> <li>others</li> </ul>

Source: self-study based on Nowakowski & Werbińska- Wojciechowska, 2012, p. 34

Modern literature provides a lot of tools, methods and procedures used in suppliers evaluation and selection process. Recently however, Multiple Criteria Evaluation Method has been becoming increasingly important. Next section of this paper presents detailed description of the above mentioned method.

<sup>&</sup>lt;sup>5</sup>http://www.ebz-beratungszentrum.de[access June 27,2016]

# **3. MULTIPLE CRITERIA DECISION MAKING/AIDING METHODOLOGY** (MCDM/A)

#### 3.1. Methodological Background of MCDM/A

Multiple Criteria Decision Making methodology, which derived from the operational research, is a mathematical method supporting the decision making process. It is applied to evaluate different aspects of the considerate variants (hardly comparable) in order to select the best alternative. Such method supports decision maker (DM) (person who defines decision problem) with rules, tools and methods in solving complex decision problems, considering several – often contradictory – points if view (Figueira et al., 2005, p. 21; Vincke, 1992, p. 33). Multiple criteria analysis facilitates decision making process, starting with defining the objectives, creation of the variants and finally, selection of the most desired one (Walentynowicz & Jankowska-Mihułowicz, 2012, p. 207). It provides thorough analysis of all the criteria defined by the decision maker in search for the most desired alternative (Roy, 1990, p. 324-331; Roy, 1990, p. 71).

MCDM/A is a methodology in which, having defined a set of actions (variants/ solutions) A and a consistent family of criteria F, it tends to (Galińska et al., 2015, p. 140-144):

- determine the subset of actions (variants, solutions) considered as the most desired in aspect of family of criteria (choosing problem),
- divide A into subsets according to concrete classification rules (sorting problem),
- rank actions (variants, solutions) from the best to the worst (ranking problem).

The set of A can be defined as set of objects, decisions, solutions, variants or actions, which are analysed in decision process. The consistent family of criteria F should be characterized by the following features (Żak, 2014, p. 7141-7153):

- it should provide a comprehensive and complete evaluation of all considered variants,
- it should have a specific direction of DM's preferences,
- the domain of each criterion should be disjoint with the domains of other criteria.

Each criterion in the family of criteria F is used to evaluate the A set and represents the DM's preferences in relations to a proper aspect of a decision problem.

Various methods and tools are used to solve the multiple criteria decision problems. In general, they can be divided into three groups:

- 1. Methods derived from the multi-attribute utility theory e.g. UTA (Figueira et al., 2005, p. 34), AHP (Saaty, 1980, p. 66; Saaty, 1995, p. 81-126),
- Methods based on the outranking relation e.g. Electre I–IV (Roy, 1990, p. 324-331; Roy, 1990, p. 127), Promethee (Figueira et al., 2005, p. 213), Oreste,
- 3. Interactive methods called multiple objective local evaluation methods based on the trial and error approach implemented in the specific interactions e.g. Light Beam Search – LBS) (Książek, 2001, p. 555-561).

In this article, the computational experiments have been carried out with the application of two multiple criteria analysis methods i.e.: Electre III/IV and AHP method. From a methodological point of view they represent two alternative schools of MCDM/A. AHP method belongs to the American school of MCDM/A and it is based on the multi-attribute utility theory (Keeney & Raiffa, 1993, p. 76). Electre III/IV represents the MCDM/A method of the European/French originand is based on the binary outranking relation. However, both methods can be used to solve the multiple criteria decision problem of choosing the supplier for the manufacturing company.

#### 3.2. Characteristics of Electre III/IV Method

Electre III/IV method is the multiple criteria method of ranking the finite set of variants which are evaluated with the application of the set of criteria. The method is one of the universal multiple criteria ranking methods based upon the outranking relation (Figueira et al., 2005, p. 33; Roy, 1990, p. 48; Vincke, 1992, p. 71; Żak, 2005, p. 89). The procedures carried out with the application of Electre III/IV method aim at the construction of preference model on the basis of pairwise comparisons of all decision variants taking into account the thresholds which define the relation between these variants (Stachowiak, 2002, p. 132).

Computational algorithm of Electre III/IV comprises of three stages: (Galińska et al., 2015, p. 140-144)

- I. matrix evaluation construction and definition of the DM's preference model,
- II. outranking relation construction,
- III. outranking relation implementation.

First stage starts from the definition of the set of solutions (variants) A and the consistent family of criteria F. Then, it is necessary to specify the value of particular criterion functions and wage indexes for the each of criterion (criterion wages). Finally, the DM's preference model is defined via the thresholds of indifference qj', preference pj' and veto vj' as well as the importance indexes. It is bound by a principle as follows: qj'<pj'<vj'.

On the second stage of the method, the consistency indexes C(a,b) are computed for every pair of variants (a,b). These are presented in the form of a consistency matrix. Their values indicate to what extent the a and b are consistent with the statement that a outranks b in relation to all other criteria. Then, the inconsistency index Dj(a,b) is computed for every criterion j. The inconsistency index contradicts the statement that a outranks b. Finally, the outranking relation S(a,b) is structured which is defined as the outranking degree d(a,b) that is the aggregated measure of variants evaluation based on the consistency C(a,b) and inconsistency Dj(a,b) indexes. S(a,b) is an overall measure which specifies to what degree a outranks b. Outranking/Reliability degrees construct the reliability matrix.

On the third stage of Electre III/IV algorithm, the variants are ranked on the basis of the outranking degrees S(a,b). First it is a preliminary ranking structured with the application of descending and ascending distillations which rank the variants form the best to the worst. Afterward, the final ranking is structured on the basis of descending and ascending preorders. As the result, the variants are finally ranked. Between the

variants the following relations may occur: indifference "I", preference ">", non-preference "<" and incomparability "R".

#### 3.3. Characteristics of AHP Method

Analytic Hierarchy Process Method (AHP) is based on hierarchical analysis of decision problems. Using the method, it is possible to decompose a complex decision problem and make the final ranking for the definite set of variants. AHP method facilitates the process of choosing the decision variants which can be either some physical objects (machines, goods) or some states which are represented by the defined variants. The method encompasses the multiple criteria approach which is based on the strategy of modeling the DM's preferences and on the assumption that the variants are comparable. Since the multiple criteria approach presumes that preferences are natural in the process of evaluation carried out by a person, the method takes into account the DM's preferences which gives the evaluation a subjective character (Downarowicz et al., 2000, p. 7).

The AHP method was formulated by Thomas L. Saaty (1990, p. 9-26; Saaty, 1980, p. 55) who claimed that human judgements are always relative and depend on the DM's characteristic, his role and his system of values. As the result, one may observe various approaches to the decision problem (the object of evaluation) which manifest itself in different importance wages of partial utilities of specific variants which are the same with the criteria of evaluation. The above statement indicates that the AHP method is in line with the utility theory (Downarowicz et al., 2000, p. 8).

The algorithm of the AHP method consists of four phases (Saaty, 1980, p. 55; Żak, 2011):

- I. the making of the hierarchical structure of the decision process, so firstly the overall description of the problem and secondly the deconstruction of the problem to the simple parts which are the elements of the hierarchy; in particular the definition of the aim of the decision process, criteria and sub-criteria of the evaluation and evaluated variants;
- II. the naming of the DM's preferences in the form of the preferences matrix expressed on the 1 to 9 point scale (implemented by Saaty) and calculation of normalized absolute importance evaluation of all elements of the hierarchy;
- III. the examination of the global consistency of the preferences matrix on the all levels of the hierarchy through calculation of the matrix consistency index CI and comparison of it with the limit value (CI < 0.1);
- IV. generation of the final ranking of variants based on the aggregated utility measure Ui of each of the variants. The measure is represented by a utility function.

Ranking, which is the final result of the algorithm of the AHP method, ranks the variants from the best to the worst in accordance with calculated utility values Ui starting from the highest to the lowest value.

#### 3.4. The proposed methodology of selecting the suppliers in clothing industry

Based on the literature review and the previous authors' works they propose the universal procedure for evaluation and selection of the most desirable supplier. The proposed an approach which based on the universal procedure of solving the multiple criteria decision problems and customized to specific features of the suppliers' selection problem. It includes the following stages (Żak & Galińska, 2017, p. 131-132):

- I. Investigation of the decision situation and its verbal description.
- II. The suppliers' selection problem structuring and mathematical modeling. Formulating the suppliers' selection problem as a multiple criteria ranking problem. Definition of variants A and a consistent family of criteria F.
- III. Analyzing, modeling and aggregating the Decision Maker's preferences.
- IV. Review, evaluation and selection of the appropriate multiple criteria methods (computational procedures, algorithms) to rank the suppliers from the best to the worst.
- V. Carrying out a series of computational experiments. Solving the suppliers' selection problem with an application of the global model of preferences and selected MCDM/A methods.
- VI. Selection of the most desired variant supplier, the winner in the generated rankings and the compromises solution that best matches the trade-offs and expectations of the Decision Maker.

The stages have a universal/ generic character and can be applied to solve any category of the multiple criteria decision problems, further formulated as ranking problems. Also, the presented methodology can be used to analyse and select the suppliers operating in various industries, which is further analyzed and confirmed in previous works' of the authors.

### 4. DESCRIPTION OF THE DECISION SITUATION

#### 4.1. Verbal Characteristic of the Decision Problem

The issue considered in this paper is evaluation and selection of a supplier of goods for a company operating in the clothing industry which specializes in manufacturing and distribution of clothing, shoes and accessories to variety of clients in different age groups. The company is one of the leading business entities in retail clothing market operating in the Central and Eastern Europe.

Company's business activity is divided into fashion and discount sector which are substantially different. 700 entities operate within both sectors.

Discount sector comprises the chain of shops with cloths and accessories for women, men and kids. The collection is complemented with household textiles and shoes. Good relation of cloths' quality to their price and broad network of distribution (400 stores in Poland and abroad on the Romanian, Czech and Slovak markets) are the most important advantages of the chain. In the stores often are available known and branded goods of Polish manufacturers and importers. Moreover, the company, in a dynamic way, develops e-commerce channel by selling its products online in the biggest discount clothing store.

In the sector of fashion, the company develops, promotes and distributes its three well-known clothing brands created by designers who work for the company. The sample collection is manufactured in the parent's company factory whereas the final collection is manufactured in over 100 factories in Poland and abroad, especially in China, India, Bangladesh, Turkey, Hong Kong and Pakistan, which is in line with outsourcing rules. The goods are distributed in the retail stores and online. The chain of shops in fashion sector comprises about 300 entities in Poland and abroad.

The company is going to produce for the autumn-winter collection cloths made of the fabric which contains the UV stabiliser. The fabric is light, breathable and does not stretch out. Taking into consideration that the company has not used this kind of fabric yet, the Board of Directors (acting as the Decision Maker (DM) in the decision situation described) has decided to purchase the fabric from the local producer. Afterward, the clothing with the UV stabiliser, being the sample collection, would be manufactured in the parent's company factory and not in a company of an external supplier which is in accordance with the company's policy. It allows the full control over the process of production and guarantees fair quality of the manufactured clothing. Such approach stands the company out of the competition and is highlighted in many advertising campaigns in which the main focus is not only the fact that the collections are fashionable but also that they are made of high-quality fabrics and with the best technologies.

#### 4.2. Definition of Variants

The following autumn-winter collection of clothing is going to be based on the new fabric which contains the UV stabiliser. Taking into consideration the company's policy, the decision has been made that the fabric would be purchased from the local/national manufacturers and the sample collection would be manufactured in the parent company's factory. The company decided to verify in detail, possibilities of Polish manufacturers due to the fact that this type of the fabric has been never before purchased by the company. Besides, the Board of Directors (the DM) decided to take into consideration only local manufacturers who operate in the maximum proximity of 150 km from the company's main office. Such criteria for selection of the suppliers are supposed to reduce the time of delivery and ensure the possiblity to supply relatively often small batches of the fabric which directly enters the production process. Moreover, it facilitates the usage of modern management strategies including Just-in-Time concept. Another advantages of purchaising the fabric from the local suppliers are: reduction of storage costs, improvement of the logistics and overall economic profits. Finally, the location of the company's main office enhances the cooperation with local suppliers since in the lodzkie voivodship are located offices of many successful companies from the clothing industry.

The company needs to cooperate with the trusted suppliers so that the implementation of the Just-in-Time concept would be possible. The problem of selection of the suppliers is defined as the multiple criteria task of ranking the variants. Variants taken into consideration in the case study from D1 to D5 stand for the suppliers of the fabric which contains the UV, what is described in Table 1.

SUPPL	LIERS	CHARACTERISTIC
		Large production and service undertaking, located 30 km from the
D1		customer, existing 25 years on the market.
		Medium production undertaking, located 15 km from the customer,
D2		existing 30 years on the market.
		Large production undertaking, located 70 km from the customer,
D3		existing 22 years on the market.
		Small production and service undertaking, located 50 km from the
D4		customer, existing 9 years on the market.
		Medium production undertaking, located 35 km from the customer,
D5		existing 17 years on the market.

**Table 1.** Characteristic of variants – fabric suppliers – in the case study

The DM has not cooperated yet with the manufactures who offer fabric with the UV stabiliser so the selection of the supplier has to be well-thought and based on the detailed analysis. The multiple criteria would be taken into consideration to carry out the analysis. The criteria, which are believed by the DM to be the most important, are e.g.: the quality of the fabric delivered, timeliness of the supply, its security and flexibility.

#### 4.3. Definition of the Consistent Family of Criteria

The decision process related to selection of supplier of the fabric with the UV filter has been based on the evaluation of 5 suppliers. To verify them, the model proposed by Galińska and Żak has been used (Żak & Galińska, 2017, p. 135-137). The model points to 9 evaluation criteria. The importance wages of the criteria were formulated on the basis of the interview with the DM, his preferences and aspirations. Criteria K1-K9 are described in detail in the Table 2.

nave been evaluat	uated in the case study					
CRITERIA	SUB-CRITERIA	DESCRIPTION				
K1	K1.1: Unit cost of the	The sub-criterion specifies the total unit				
Product price	product delivered	cost of purchasing of 1 linear metre of				
and payment		the product - fabric with the UV				
conditions		stabiliser, expressed in PLN. The sub-				
		criterion is minimized.				
	K1.2: Payment	The sub-criterion specifies the payment				
	conditions	date, expressed in the number of days.				
		This sub-criterion is maximized.				
K2		The criterion specifies the share of the				
Timeliness of		deliveries completed in the due date. It				
delivery/		is the maximized criterion, expressed in				
supplier		percentage.				

**Table 2.** Description of criteria on the basis of which the variants – fabric suppliers – have been evaluated in the case study

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K3 Reliability of delivery	K3.1: Share of deliveries of products in appropriate quantity and conditions (undamaged) K3.2: Share of deliveries carried out as agreed	This sub-criterion stands for the delivery of the right product in the proper quantity and quality. The sub-criterion is maximized and expressed in percentage. The sub-criterion specifies the percentage of deliveries performed in accordance with the timetable and agreement. It is expressed in percentage and equals to the share of applicable agreement performance. This sub-criterion is maximized.
	K3.3: Quality of the product delivered	The sub-criterion specifies the percentage of products delivered in the expected and demanded quality. This sub-criterion is maximized and expressed in percentage.
K4 Cost of delivery		The criterion specifies the delivery cost, expressed in PLN. It is the minimized criterion.
K5 Accessibility of supplier	K5.1: Time-oriented accessibility	The sub-criterion specifies the frequency of product delivery possible to perform in the period of one week, expressed in days. The sub-criterion is maximized.
	K5.2: Geographical accessibility	The sub-criterion specifies the spatial distance/ the length of road to the nearest warehouse of the supplier. It is expressed in the number of kilometers. The sub-criterion is minimized.
K6 Customer Service Quality (during the supply process)	K6.1: Level of customer support (info, monitoring, problem solving, reaction)	The sub-criterion comprises such elements as: constant monitoring of the supply and giving the information about the supply to the customer, ability of solving the problems which occur during the process of delivery, immediate response to the existing situation. The sub-criterion is maximized, expressed in 1-5 point scale.

	K6.2: Flexibility of the supplier (in changing the order)	The sub-criterion enables the measurement of the supplier's responsiveness to the unexpected/ additional order. The sub-criterion is expressed in the number of days that the supplier needs to complete an unexpected order made by the company. The sub-criterion is minimized.
K7 Market position of the supplier	K7.1: Market experience of the supplier K7.2: Market share	The sub-criterion specifies the number of years that the supplier exists on the market. It is the maximized sub- criterion, expressed in the number of years. The sub-criterion specifies the supplier's share in the market. This sub- criterion is maximized, expressed in the
K8 Performance of the supplier	K8.1: Efficiency of human resources (sales/ employee) K8.2: Assets turnover	percentage. The sub-criterion is expressed as the index: sale per the worker. The sub- criterion is maximized, expressed in PLN. The sub-criterion specifies the company's effectiveness of the fixed assets management. It is expressed as the relation between the value of annual sale to the value of assets of the particular supplier. The sub-criterion is maximized.
K9 Modernity of the supplier		The criterion indicates to the supplier's technological and organizational advantages. It comprises such elements as: technological know-how, availability of advanced machines and devices, their quality and modernity, the implementation of modern management concepts (lean management, JiT), the implementation of methods and technics related to environment protection. The criterion is maximized, expressed in 1-5 point scale.

The criteria listed and discribed in the Table 2 would be neccessary in evaluation of the suppliers taken into account in the case study. The DM indicated the following criteria as the most important (the highest wage of the criterion): the quality of the

delivered product, delivery timeliness, delivery security, price of the product and flexibility of the delivery process.

The evaluation matrix has been constructed (Table 3) on the basis of the nine suppliers evaluation criteria defined above and the original raw data.

CRITERIA		SUPPLIERS				
		D1	D2	D3	D4	D5
K1	K1.1 [PLN]	24,1	24,5	23,5	25	25,5
	K1.2 [Days]	30	21	21	14	30
K2 [%]		0,95	0,98	0,85	0,9	0,95
K3	K3.1 [%]	0,99	0,95	0,9	1	0,95
	K3.2 [%]	0,9	0,95	1	0,85	0,98
	K3.3 [%]	0,99	0,95	0,95	0,90	0,99
K4[PLN]		174	87	406	290	203
K5	K5.1 [Days]	5	4	5	3	5
	K5.2 [KM]	30	15	70	50	35
K6	K6.1 [Points]	5	4	3	4	2
	K6.2 [Days]	1	2	1	3	2
K7	K7.1 [Years]	25	30	22	9	17
	K7.2 [%]	0,083	0,061	0,092	0,012	0,056
K8	K8.1 [PLN]	48000	37000	53000	20000	35000
	K8.2 [ - ]	8,3	4,9	7,5	3,1	8,9
K9						
[Points]		5	4	4	3	3

Table 3. The evaluation matrix based on raw data in the case study

In the case study described the raw data have been properly processed. Computational experiments are presented in detail in the following section of the paper.

#### 5. COMPUTATIONAL EXPERIMENTS

#### 5.1. The Supplier's Ranking Based on the Electre III/IV Method

In accordance with the Electre III/IV method algorithm, the evaluation matrix has been constructed (Table 3), which contains the all variants' evaluation – suppliers of the fabric with the UV stabiliser (D1, D2,...D5) in relation to all criteria (K1, K2,...K9). The data from the evaluation matrix have been processed in the computer programme MCDM ToolKit, which is the computer implementation of this method.

Afterward, the DM's preference model has been defined in the process of naming the wages of criteria and thresholds: indifference threshold q, preference threshold p and veto threshold v, which are the mode of expression the DM's sensitivity to the changing value of criteria. The model has been presented in Table 4, which is the screenshot of the MCDM ToolKit programme.

			5				
Preference information							
Preference direction	Weight	Indifference threshold	Preference threshold	Veto threshold			
Decreasing (Cost)	8,000	0,5	1	2			
Increasing (Gain)	2,000	0	9	30			
Increasing (Gain)	9,000	0,03	0,1	0,3			
Increasing (Gain)	7,000	0,03	0,1	0,3			
Increasing (Gain)	8,000	0,03	0,1	0,3			
Increasing (Gain)	10,000	0,03	0,1	0,3			
Decreasing (Cost)	3,000	50	200	500			
Increasing (Gain)	7,000	0	1	3			
Decreasing (Cost)	3,000	20	50	150			
Increasing (Gain)	2,000	0	1	3			
Decreasing (Cost)	8,000	0	1	3			
Increasing (Gain)	4,000	5	10	30			
Increasing (Gain)	5,000	0,005	0,02	0,1			
Increasing (Gain)	7,000	2000	10000	30000			
Increasing (Gain)	6,000	1	3	8			
Increasing (Gain)	5,000	0	1	3			
	Preference direction Decreasing (Cost) Increasing (Gain) Increasing (Gain) Increasing (Gain) Increasing (Gain) Decreasing (Cost) Increasing (Gain) Decreasing (Cost) Increasing (Gain) Decreasing (Cost) Increasing (Gain) Increasing (Gain) Increasing (Gain) Increasing (Gain) Increasing (Gain)	Preference direction         Weight           Decreasing (Cost)         8,000           Increasing (Gain)         2,000           Increasing (Gain)         9,000           Increasing (Gain)         9,000           Increasing (Gain)         9,000           Increasing (Gain)         8,000           Increasing (Gain)         10,000           Decreasing (Cost)         3,000           Increasing (Gain)         7,000           Decreasing (Cost)         3,000           Increasing (Gain)         2,000           Decreasing (Cost)         8,000           Increasing (Gain)         4,000           Increasing (Gain)         5,000           Increasing (Gain)         7,000           Increasing (Gain)         7,000	Preference direction         Weight         Indifference threshold           Decreasing (Cost)         8,000         0,5           Increasing (Gain)         2,000         0           Increasing (Gain)         9,000         0,03           Increasing (Gain)         9,000         0,03           Increasing (Gain)         8,000         0,03           Increasing (Gain)         10,000         0,03           Increasing (Gain)         10,000         0,03           Decreasing (Cost)         3,000         50           Increasing (Gain)         7,000         0           Decreasing (Cost)         3,000         20           Increasing (Gain)         2,000         0           Decreasing (Gain)         2,000         0           Increasing (Gain)         4,000         5           Increasing (Gain)         5,000         0,005           Increasing (Gain)         5,000         0,005           Increasing (Gain)         7,000         20000           Increasing (Gain)         6,000         1	formation         Preference direction         Weight         Indifference threshold         Preference threshold           Decreasing (Cost)         8,000         0,5         1           Increasing (Gain)         2,000         0         9           Increasing (Gain)         9,000         0,03         0,1           Increasing (Gain)         7,000         0,03         0,1           Increasing (Gain)         8,000         0,03         0,1           Increasing (Gain)         10,000         0,03         0,1           Increasing (Gain)         10,000         0,03         0,1           Decreasing (Cost)         3,000         50         200           Increasing (Gain)         7,000         0         1           Decreasing (Cost)         3,000         20         50           Increasing (Gain)         2,000         0         1           Decreasing (Cost)         8,000         0         1           Increasing (Gain)         2,000         0         1           Increasing (Gain)         5,000         0,005         0,02           Increasing (Gain)         5,000         0,000         10000           Increasing (Gain)         7,000         2000<			

Table 4. The DM's preference model in the case study

In the second stage of the algorithm of Electre III/IV method, the outranking relation has been constructed. To build the outranking relation, the matrix of concordance and discordance were generated. The concordance matrix comprises concordance indexes C(a,b) and the discordance matrix comprises the discordance indexes Dj(a,b). On that basis, the credibility matrix has been obtained which is presented in Table 5. The matrix contains the outranking and credibility degrees d(a,b), which are the aggregated measure of the variants evaluation and representation of the outranking relation S(a,b). Each credibility degree specifies the extent to which globally 'a outranks b'.

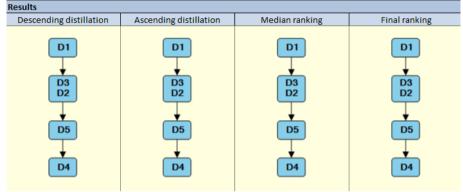
Credibility matrix							
Alternative	D1	D2	D3	D4	D5		
D1	1,000	0,968	0,856	1,000	0,939		
D2	0,449	1,000	0,333	0,979	0,660		
D3	0,302	0,376	1,000	0,863	0,778		
D4	0,000	0,063	0,000	1,000	0,026		
D5	0,000	0,333	0,000	0,479	1,000		

**Table 5.** Credibility matrix in the case study

The outranking relation S(a,b) has been used on the third stage of the algorithm. As the result of the ascending and descending distillations carried out, the complete preorders were structured. Then, they have been averaged into the median ranking and the intersection of preorders resulted in the final ranking – Figure 2.

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Figure 2. Final results of the computational experiments carried out with the application of Electre III/IV method in the case study



Graphical final ranking is presented in the tabular form as the so called outranking matrix which is also known as the final relation matrix, depicted in Table 6. The matrix includes final relation of the variants – suppliers of the fabric with the UV stabiliser, expressed in the following form: indifference (I), preference (>), inverse of preference (<) and incomparability (R).

Relation matrix							
Alternative	D1	D2	D3	D4	D5		
D1	I	>	>	^	>		
D2	<	I	I	^	>		
D3	<	I	I	^	>		
D4	<	~	<	-	<		
D5	<	<	<	>	I		

Table 6. The outranking matrix (final relation) in the case study

The final ranking and the outranking matrix point to the D1 supplier, which is the definite leader of the ranking, as the most preferable variant. Its most important advantages are: delivery timeliness (K2) and supplier's reliability (K3.1). Moreover, the supplier offers outstanding quality of the fabric (K3.3), which is particularly important for the DM – Board of Directors of the manufacturing company. Variant D1 has at the same time few disadvantages. What is really interesting, this supplier does not offer the cheapest fabric which means that positive features of the variant compensate for that disadvantage.

The least desired variant is D4, which is presented as the one with many disadvantages. It is the small production and service undertaking which offers the fabric for high unit price (K1.1) and average quality (K3.3). Besides, the undertaking does not guarantee enough security (K3.2) of the supply which is, together with the quality of the fabric, one of the most important characteristic for the DM. Finally, the D4 variant characterizes the least effectiveness of the supply (the supply frequency which is possible to ensure within one week; K5.1).

#### 5.2. The Ranking of Suppliers with the Application of AHP Method

The variant and criteria for evaluation have been defined on the first stage of the AHP method algorithm. Then, the authors of the paper set about forming the DM's preference model.

Forming the DM's preference model (second phase of the algorithm), the pairwise comparison has been used which is characteristic for the AHP method. Each element of the hierarchy has been compared with another one and labeled with a proper importance/preference degree on 1 to 9 point scale. Each number on that scale corresponds to the preference strength of one element in relation to the other. All of the indexes have compensatory nature which means that the evaluation value of less important element is reversal to the evaluation value of the more important one. The pairwise comparisons have been carried out for the criteria, sub-criteria and evaluated variants – suppliers of the fabric with the UV stabiliser. The absolute and normalized wage of criteria/sub-criteria/variants has been generated for each matrix.

Pursuant to the computational scheme of the AHP method, the consistency indexes CI for each matrix of relative weights at each level of the hierarchy (criteria, sub-criteria and variants) have been calculated in the third phase of the algorithm. In the analyzed case study 23 CI-s have been computed, including 1 for criteria level, 6 for the sub-criteria levels and 16 for variants compared against each criterion.

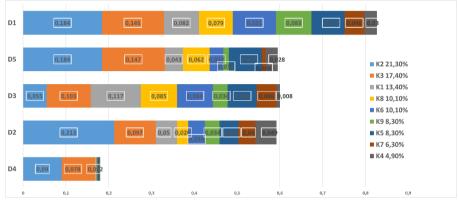
In the fourth phase of the algorithm, absolute and normalized importance wages of the elements of the hierarchy have been aggregated by means of the utility function Ui. On this basis, the final rankings of the variants have been constructed and depicted in the Table 7 and Figure 3.

Table 7. The values of utility of each variant generated in the computational procedure
based on the application of AHP method in the case study

	Alternative	Score
	D1	0.827
	D5	0.605
	D3	0.601
	D2	0.592
$\checkmark$	D4	0.286

Table 7 presents the computed utilities Ui of each variant – supplier, with its absolute values. Figure 3 shows the classification of variants based on their generated utilities in the form of graph. Each variant, presented on the graph, is featured by the level of computed utility (from 0.286 - D4 to 0.827 - D1 in the absolute values). The winner of the ranking generated with the application of AHP method is supplier D1. The weakest variant that occupies the bottom position of the ranking is D4.

**Figure 3.** Graphical representation of the final ranking generated with the application of AHP method in the case study



The results generated with the application of two different methods of multiple criteria analysis i.e. Electre III/IV and AHP are fast identical. Both methods clearly indicate that the best supplier in the described situation for the examined company is D1 variant which substantially outranks all other variants. The authors of this paper recommend to choose D1 supplier as the most universal and desired from the perspective of many different evaluation criteria.

#### 6. CONCLUSION

This paper presents the universal methodology for solving the problem of choosing the supplier of fabric with the UV stabiliser. In the presented methodology, the rules of multiple criteria decision making/aiding (MCDM/A) are implemented, as well as the traditional algorithm of proceedings in the situation of solving the multiple criteria decision problem. The decision problem was formulated as the multiple criteria problem of ranking variants. To construct the final ranking of suppliers, the methods Electre III/IV and AHP have been used.

The paper has methodological and utilitarian values. It indicates how the complex analyses and evaluation of the suppliers should be carried out to construct the final ranking of the variants from the best to the worst in the multiple criteria sense.

On the methodological grounds, the most important author's achievement is presentation of the all stages of proceedings applied in solving the multiple criteria decision problem (ranking of variants), which is, in the described case study, selection of the fabric supplier for the company operating in the clothing industry. The authors present the procedure of defining the variants (suppliers), specify the consistent family of criteria and their evaluation, identify and model the DM's preferences, carry out computational experiments using two different methods of multiple criteria analyses, generate solutions and choose the most desired supplier. Moreover, the authors show the advantages of Electre III/IV and AHP methods as the universal tools of multiple criteria analysis which are ideal for the process of evaluation of fabric suppliers. This paper can be used in practice since the authors demonstrate that the best solution is supplier D1, who in terms of multiple criteria evaluation is characterized by many advantages, offering at the same time not the lowest price for the product. The authors of the article recommend this variant as the most desired solution of the decision problem.

In the authors' opinion further research should be carried out in two directions:

- I. Application of alternative MCDM/A methods (Promethee, ANP, UTA) to the evaluation of different categories of suppliers and in-depth analysis of their suitability, strengths and weaknesses.
- II. Further analysis of suppliers' selection processes in different industries. Comparison of evaluation criteria, aspects considered and interests of various stakeholders. This research should finally confirm the consistency and universality of the proposed family of criteria.

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# IV. CONTEMPORARY SUPPLY CHAIN CHALLENGES

# DEVELOPMENT OF THE INTERMODAL MARKET IN POLAND FROM THE PERSPECTIVE OF CARGO HANDLING OPERATIONS IN INTERNATIONAL SUPPLY CHAINS – SELECTED ISSUES

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#### Abstract

A significant role within the framework of the European Union's policy of sustainable transport development is assigned to the intermodal transport. The development of the intermodal market, particularly with regard to the international carriage of goods has been observed also in Poland over the last several years. Nevertheless, the share of intermodal transport in the total cargo transport differs from the best Western European models. In 2016 12.8 million tonnes of cargo (over 23% more than in 2015) were carried using the intermodal transport in Poland. The intermodal market in Poland has its specificities - it is a rail intermodal market on which 96.4% of the transported intermodal units in 2016 were containers. Due to its geographical location, Poland has a large potential for handling containerized cargo flows in the framework of international supply chains. Intermodal transport is used on several major routes: North-South - as transport to and from Polish seaports, transport from Poland to Western European seaports, and the East-West transport (including but not limited to transit through Poland). The main purpose of this article is to discuss the current status of the development of the intermodal market in Poland in terms of its role in handling cargo flows in international supply chains. In addition, the aim is to identify factors supporting further development and the barriers that disturb this development. Research of literature, analysis of statistical data published by the Central Statistical Office, analysis of reports published by the Office of Rail Transport (the Polish rail market regulator) and information from entities operating in the intermodal market in Poland (including intermodal operators) were conducted to accomplish the main objective of the article. The performed analysis related to both the infrastructure issues concerning the intermodal market in Poland and its organization-based, formal and legal, and economic aspects. Moreover, selected external circumstances forming the intermodal market position in Poland in handling international supply chains, including but not limited to the development the new Silk Road initiative have been discussed. The findings and conclusions arising from the conducted analysis can serve as examples and guidance for other countries in which the role of intermodal transport should also be strengthened.

**Key words:** intermodal transport, intermodal market in Poland, international supply chains, containerized cargo flows, development of intermodal market

#### 1. INTRODUCTION

The development of intermodal transport constitutes one of the crucial areas of interest for the EU transport policy. It provides grounds for the implementation of the EU policy of transport sustainable development. References to intermodal transport<sup>1</sup> and its role in balancing the transport system can be found in numerous transport-related documents issued by the EU institutions. One of the crucial documents is White Paper on transport from 2011, which determines the goals of competitive and resource-efficient transport system: "Thirty per cent of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than fifty per cent by 2050, facilitated by efficient and green freight corridors. Meeting this goal will also require appropriate infrastructure to be developed" (European Commission, 2011, p. 9). Over the years, the EU institutions have implemented various programs aiming at facilitating the development of intermodal transport, e.g. PACT, Marco Polo I and II (Grzelakowski, 2014, p. 13). The advantages of intermodal transport are undisputable. Their pro-ecological character has been underlined in numerous reports and discussed in reference publications.

The intermodal transport is used in freight services in the hinterland of seaports, in particular in handling the flows of cargo in the global supply chains where the main section involves transport by sea<sup>2</sup>. The development of intermodal transport has been observed in Europe and North America. Each of these markets has its own specificity (Colliers International, 2015, p. 7-9). The intermodal terminals operate as the so-called *dry ports* or *inland ports* of various types (Talley, Ng, 2017, p. 175, 176). When considering their role for the entire supply chain, it is assumed that such facilities considerably affect the effectiveness of logistics corridors (Ambrosino et al., 2015, p. 106). The reference publications discuss also the role of intermodal transport for the optimal supply chain logistics (Bhattacharya et al., 2014, p 73). Moreover, it is clear that the possibility to provide various services is conditioned by proper logistics infrastructure, and that the exchange of information and involvement of various groups is also important (e.g. terminal operators, carriers), which is leading to the Supply Chain Integration (Clott, Hartman, 2016, p. 131).

Poland, a large Central European country, thanks to the location has got potential for the development of intermodal transport and for handling containerized cargo flows in the framework of international supply chains. Intermodal transport is used on

<sup>&</sup>lt;sup>1</sup>In the article there is no additional distinction for combined transport. We need to add that intermodal transport is understood here as: "The movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes", and combined transport as: "Intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible". (UN/ECE, 2001, p. 17,18)

<sup>&</sup>lt;sup>2</sup> Following UNCTAD we need to indicate: "in 2015, world seaborne trade volumes are estimated to have accounted for over 80 per cent of total world merchandise trade" – i.e. 10 047 millions of tons loaded, with 1 687 millions of tons loaded among them as containerized cargo (UNCTAD, 2016, p. 6-7).

several major routes: North-South - as transport to and from Polish seaports, transport from Poland to Western European seaports, and the East-West transport. However, there are also some obstacles. Among them, for a number of years we have indicated, e.g.: status of linear and nodal transport infrastructure, shortage in rolling stock, disproportions in financing the infrastructure of particular transport sectors or lack of sufficient promotion of such services (UTK, 2012, p. 32). Over time, in some of the above mentioned sectors we have observed some improvement. It results from subsequent documents issued and from particular activities (e.g. regarding infrastructure modernization). They are necessary since in recent years, in Poland, the volume of foreign trade has been rapidly increasing. Poland has also been the transit country. The cargo must be transported effectively and sustainably, and intermodal transport is a solution.

The above mentioned geographical location and economic and political situation place Poland in important position in handling the flows of cargo in international (also global) supply chains. The Polish seaports and container terminals located there constitute gateway to imported cargo to Europe and cargo exported from Europe by sea (they undoubtedly compete for the role with the ports of Western Europe). The role of intermodal transport should be strengthened by services in the hinterland of the ports. When considering the flow of freight in international supply chains we also need to pay attention to land transport between Europe and the Far East, in particular within the new Silk Road. This direction will undoubtedly gain in importance. Poland may potentially become an important European participant of this initiative, too.

Therefore the main purpose of this article is twofold: 1) to discuss the current status of the development of the intermodal market in Poland in terms of its role in handling cargo flows in international supply chains, 2) to identify factors supporting further development and the barriers that disturb this development. Research of literature, analysis of statistical data published by the Central Statistical Office, analysis of reports published by the Office of Rail Transport (the Polish rail market regulator) and information from entities operating in the intermodal market in Poland (including intermodal operators) were conducted to accomplish the main goal of the article.

The paper is divided into four chapters. After the *Introduction* chapter 2 (*Characteristics of Intermodal Transport in Poland*) and chapter 3 (*Intermodal Services in Poland and International Supply Chains*) of this article involve analysis of intermodal market in Poland and selected conditions for its development. Its objective is to present details of the current situation and indicate opportunities for strengthening the role of the market in international supply chain services. The analysis relates to the infrastructure issues concerning the intermodal market in Poland and legal, and economic aspects. Moreover, selected external circumstances (e.g. new Silk Road initiative) forming the intermodal market position in Poland in handling international supply chains have been discussed. Chapter 4 presents *Conclusions*.

#### 2. CHARACTERISTICS OF INTERMODAL TRANSPORT IN POLAND

#### 2.1. Basic Information on the Market of Intermodal Transport in Poland

From the beginning of economic transformation in Poland we can observe interest in the development of intermodal service market. In a formal manner, it was noticeable already in 1994, when document entitled Transport policy was published, including suggestions for the necessity to establish favourable conditions for the development of combined services (Engelhardt, 2015, p. 11). Over time, other documents were issued, regarding, e.g. the strategy for transport development and the national transport policy including the concept of intermodal transport. Moreover, specific effective legal solutions were provided, significantly supporting such services. In 2006, intermodal trains were granted very favourable track access charge (amounting only to ca. 15% of real own costs of access to infrastructure). However, its time of validity was not long; the preferential charge was abolished in 2009 (Engelhardt, 2015, p. 15,16). For many years, the issue of track access charge has been one of the main obstacles in the development of intermodal services in Poland (UTK, 2012, p. 31). For several years the 25% intermodal discount is applicable in Poland. The discount contributes to shifting the cargo from road to rail (Nietz, 2017, p. 30). At present in Poland binding is the programme document entitled: The Strategy for Transport Development until 2020 (with perspective until 2030). The objectives related to the development of intermodal transport include mainly the modernization and revitalization of rail infrastructure (linear and nodal) used in such services and located within the AGTC network (MTBiGM, 2013, p. 63).

To answer the question to what degree the above mentioned regulatory initiatives and granted reductions have contributed to the improvement of intermodal market, we need to analyse the changes in fundamental parameters defining the market. The analysis refereed to the last ten years, when the development became significant, disturbed only by falls during the economic crisis between 2009 and 2010 (Table 1). In terms of total volume of transported cargo, in the analysed time period, we can indicate the increase in the volume of services from ca. 4.1 million tons in 2007 to 12,8 million tons in 2016 (which totals more than 300 %). We need to indicate that in particular years (analysing the time period from 2010) their growth varied from 6% to 37%. Similar regularities can also be observed in relation to changes in the volume of transport output. In particular years (from 2010) we have also observed the annual stable increase in the number of intermodal units (all types) and the volume of freight expressed in thousands TEU (up to nearly 1.44 million TEU). It is indicated that the increase in the number of intermodal units in recent years resulted e.g. from the increased transit traffic (e.g. from China) or from the increase in the container traffic of new cargo groups e.g. biomass (UTK, 2016, p. 4). As a result, in the analysed time period, we observed the increase in the share of intermodal freight on the market of rail services in total. Still in 2003 it amounted to 0.94 % (measured by mass of goods) and 1.71% (measured by transport output), in 2011 2.37% and 4.53% respectively (UTK, 2012, p. 14), and in 2016 the values totalled 5.8% and 8.8% respectively (UTK, 2017, p. 2). We need to add that the related European average (by transport output) amounted to 17.6% already in 2010 (UTK, 2012, p. 6).

-010										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
(in million tons)	4,1	4,8	3,3	4,4	5,9	8,1	8,6	9,6	10,4	12,8
(in bn ton-km)	1,6	2,2	1,4	1,9	2,4	3,0	3,1	3,4	3,7	4,4
in thou. units	342,4	423,8	267,0	344,6	488,9	644,6	689,3	699,6	745,3	951,0
w thou TEU	540,0	692,9	429,8	569,6	798,9	1054,2	1123,4	1114,2	1151,8	1436,3
number of rail carriers*	6	6	7	5	7	9	10	12	12	13
average distance in intermodal transport (in km)	398	464	437	429	414	378	355	354	358	346

**Table 1.** Basic information on rail intermodal services in Poland between 2007 and 2016

Source: own elaboration of the author based on: (UTK, 2017, p. 2-4; UTK, 2012; Matczak, 2013, p. 151)

The specificity of the market of intermodal transport in a particular country can be additionally defined by the existence of particular type of intermodal units. In the analysed time period, in Poland, we can clearly observe the dominance of containers ISO (20' and 40'). In 2016 alone their share totalled 89.7%, but the share of other container capacities were much smaller (only several percent each), which in total amounted to 96.4% share of containers of all types in the total number of all types of intermodal units. The unusually small share, in the total volume of intermodal transport, refers to heavy vehicles (0.01%) and swap bodies (0.7%) (UTK, 2017, p. 4). Such small transport share of heavy vehicles results e.g. from the lack of specialized terminals in Poland and lack of rolling stock to handle such units. The presented structure of intermodal units transported has been characteristic for the Polish market for many years, hence we may indicate that intermodal transport in Poland involves mainly rail container transport.

When considering the information on intermodal market in Poland we need to indicate that over time the number of rail carriers has consistently been increasing (Table 1), providing intermodal unit services. Also in this respect we can observe the development of the said market (more on the subject in point 2.2.). By analysing the information provided in table 1, we can observe that from 2011 the average distance covered by the carriers has been shortening. It is unfavourable since the profitability of such undertakings decreases. At the same time, it proves better availability of intermodal services and, despite the existing obstacles, better intentions to provide services at shorter distances. To complement the image of the Polish market of rail container services we need to focus on the use of rolling stock. At the end of the third quarter of 2015, 3 078 locomotives and 10 709 platform wagons were in operation. Their average age totalled over 36 and over 30 years respectively. Therefore, the rolling stock is extremely deteriorated (UTK, 2016, p. 8). The carriers have regularly been replacing the rolling stock. It is crucial since the stock represents the carrier, in particular on the international market. The dominance of international services is characteristic for the market of intermodal transport in Poland. Together with services provided in the hinterland of the Polish seaports they include also the flows of cargo within the international supply chains. The factors affecting such direction for the development of intermodal services in Poland shall be discussed further in point 3 of the article.

#### 2.2. Subject-Based and Organizational Aspects of Intermodal Market in Poland

In Poland, as in other European countries, on the market of intermodal services there are numerous different entities, providing diversified services. They include: rail infrastructure and intermodal terminal managers, rail carriers, intermodal transport operators and their customers (who may include shippers, freight forwarders or logistics service providers) (Matczak, 2013, p. 153). Due to limited length of the text and specificity of the Polish intermodal market, this part discusses entities directly involved in the rail container transport<sup>3</sup>. The conditions of their operation on the market are influenced by the rail market independent regulator, namely the Office of Rail Transport. The Office supervises the correct application of laws regarding the said market, and the activities of the rail infrastructure managers and rail carriers.

The main manager of rail infrastructure in Poland is PKP PLK S.A. company. The entity manages over 96% of the Polish rail network and at the same time provides economic conditions for rendering services in intermodal transport (e.g. through the amount of charges imposed on rail carriers). One of the most important tasks implemented by PKP PLK S.A. involves the modernization and other activities aiming at improving the technical condition of railway lines. The funds for such implementation come from own resources as well as the Railway Fund (UTK, 2016b, p. 122). Moreover, the use of EU funds is also possible. At the same time, we need to realize that track access charge (TAC) in Poland is of relatively high level compared to those applicable in other European countries. In 2015, in Europe, the average track access charge for freight trains amounted to  $2.6 \in$  per train kilometre. At that time in Poland, the rate totalled  $3.2 \in$  per train kilometre, in Germany  $2.9 \notin$ , in Spain only 0.2  $\notin$ , and in Latvia 9.5  $\notin$  (IRG-Rail, 2017, p. 21). The above mentioned 25% intermodal discount constitutes the incentive to provide intermodal transport services.

The other important group of entities comprises rail carriers. As already mentioned, the evolution of the Polish intermodal market (one of its dimension) is undoubtedly reflected by the increase in the number of carriers. In 2007, there were 6 carriers on the market, in 2015 - 12 (Figure 1), and in 2016 the intermodal transport services were rendered by as much as 13 rail carriers (UTK, 2017, p. 4).

<sup>&</sup>lt;sup>3</sup> Issues related e.g. to road carriers or road transport infrastructure managers are omitted.

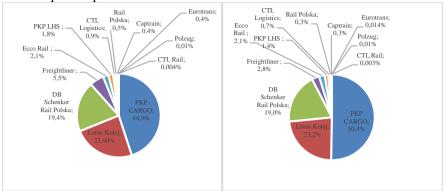


Figure 1. Carriers' share in intermodal transport in Poland (in 2015) by cargo mass and transport output

Source: (UTK, 2016, p. 3)

The intermodal operators are responsible for providing the service offer in intermodal transport. The entities are characterised by various business models. The reference publications differentiates their three main types (Matczak, 2013, p. 161-163). Firstly, typical, universal intermodal operators – organizers (purchasing particular partial services from other service providers, e.g. PCC Intermodal, Polzug). Secondly, operators from the rail carriers group (or entities related by equity - e.g. Cargosped – company of PKP Cargo Group) and thirdly, intermodal operators coming from the group of logistics operators, shipowners or road carriers (e.g. Maersk Line, Erontrans) (Matczak, 2013, p. 161-163). Moreover, there are also other hybrid models and we may undoubtedly observe more of them in the future. Already at present many intermodal operators act as intermodal terminal operators (Matczak, 2013, p. 156). Among those who can provide significant number of intermodal terminals there are: Cargosped, PCC Intermodal, Polzug, Loconi, Erontrans and Spedcont) (UTK, 2016, p. 5-6). The available terminals or capital ties between the entities on the market undoubtedly affect the operators' service offer (e.g. services provided in particular geographical directions). The intermodal operators exercise important function by combining the flows of cargo, and integrate the flows within the supply chains. They contribute to their implementation in a pro-ecological manner. Such activities are defined in the reference publications as Greening the Supply Chain.

# 2.3. Transport Linear Infrastructure in Poland for Intermodal Transport Services

Poland as a country covering the area of over 312 thousand km<sup>2</sup>, has got welldeveloped linear infrastructure network of particular transport modes. However, as mentioned above, the condition of the said infrastructure is indicated as one of the elements hampering the development of intermodal market. Therefore, we need to conduct thorough analysis of the said issue. It will focus on the components of infrastructure directly linked with rail and road container traffic in Poland. The basic information is presented in table 2. Development of the intermodal market in Poland from the perspective of cargo handling operations in... Joanna Miklińska

<b>Table 2.</b> Transport (road and ran) infrastructure in Foland						
1995	2000	2005	2010	2015		
23 986	22 560	20 253	20 228	19 231		
22 598	21 575	19 843	20 089	19 231		
11 627	11905	11 884	11 916	11 865		
13 693	12814	11 096	11 353	10 505		
237	250	254	406	420		
246	358	552	857	1559		
_*	_*	258	675	1492		
	1995 23 986 22 598 11 627 13 693 237 246	1995         2000           23 986         22 560           22 598         21 575           11 627         11905           13 693         12814           237         250           246         358	1995         2000         2005           23 986         22 560         20 253           22 598         21 575         19 843           11 627         11905         11 884           13 693         12814         11 096           237         250         254           246         358         552	$\begin{array}{c c c c c c c c c c c c c c c c c c c $		

Table 2. Transport (road and rail) infrastructure in Poland

\*-no data available

Source: own elaboration of the author based on: (CSO, 2006, p. 523), (CSO, 2016, p. 537).

Over the twenty analysed years we have observed significant development of road transport linear infrastructure in Poland. The evolution can be observed both in the total length (in thou. km) of hard surface public roads (urban and non-urban) from 237 thou. km in 1995 to 420 thou. km in 2015. At the same time, we have also observed considerably more: motorways (from 246 km in 1995 to 1559 km in 2015) and expressways from several hundred kilometres to 1492 km at the end of 2015. Actually there are in Poland, in total 1627,3 km of motorways and 1552,7 km expressways (GDDKiA, 2017) and the average network density<sup>4</sup> in Poland (in 2014) amounted to 92 km (CSO, 2016b, p. 315).

The significant improvement in the road transport infrastructure affects the development of intermodal services in Poland in two ways. On the one hand, adversely, since we can observe the development of services rendered only by road transport. On the other hand, there is also positive impact. The services provided by road transport constitute significant element (feeder system) of intermodal transport services. It is important that they are rendered on good quality roads, smoothly and quickly.

The rail transport infrastructure is of fundamental importance for the implementation of intermodal services in Poland. At present, we have in operation 19 231 km of railway lines (which ranks Poland fourth in Europe behind Germany, France and Italy in terms of the length of railway lines) (IRG-Rail, 2017, p. 14). About 54,6% of which are single track ways and over 61% of which are electrified (which constitutes the value above the European average amounting for 22 countries to - 54.6%) (IRG-Rail, 2017, p. 16). We also need to add that in the majority they are standard gauge lines (1435 mm), although we have sections of wide track (1520 mm) (with small share in the network). Network density<sup>5</sup> amounted in Poland (in 2015) to 6.2 km (CSO, 2016b, p. 315), which provides a good result compared to other European countries.

Looking back, we need to indicate that over the last twenty years (Table 2), the length of railway lines used in Poland was significantly reduced (ca. 4 755 km railway lines were withdrawn from operation). However, recently a lot of modernization works on railway lines and other elements of infrastructure have been performed. As a result, the share of railway lines which can be recognized as good quality lines, has

<sup>&</sup>lt;sup>4</sup> "Hard surface public roads per 100 km<sup>2</sup> of total area" (CSO, 2016b, p. 315).

<sup>&</sup>lt;sup>5</sup> "Standard gauge railway lines operated per 100 km<sup>2</sup> of total area" (CSO, 2016b, p. 315).

been increasing (Table 3). Although the condition<sup>6</sup> of rail infrastructure has been improving, it still significantly differs from Western European standards. The said fact requires necessary speed limitations (Figure 2) and limited permissible axle load (UTK, 2016b, p. 123). These factors constitute barriers for the development of intermodal connections (they include e.g. hinterland services to and from Polish seaports). Too slow timetable speeds make intermodal transport, in terms of transit time, much less competitive than the services provided by road transport.

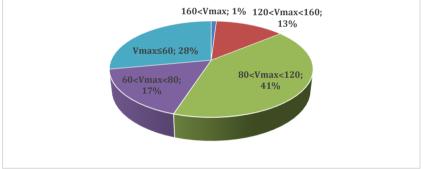
**Table 3.** Technical condition of railway transport infrastructure\* in Poland (between2010 and 2015)

36%	40%	43%	47%	51%	55%
35%	32%	30%	27%	27%	27%
29%	28%	27%	26%	22%	18%
	35% 29%	35% 32%	35%         32%         30%           29%         28%         27%	35%         32%         30%         27%           29%         28%         27%         26%	35%         32%         30%         27%         27%           29%         28%         27%         26%         22%

\*Under the management of PKP PLK SA

Source: own elaboration of the author based on: (UTK, 2016b, p. 122).

Figure 2. Share of railway line length by max. speeds in 2015



Source: own elaboration of the author based on: (UTK, 2016b, p. 124).

When analysing the importance of existing transport infrastructure for cargo handling in international supply chain, we need to realize that the main sections of newly-built road transport infrastructure (motorways and expressways) and modernized railway lines are part of the two core network corridors across Poland, TEN-T – the Baltic-Adriatic Corridor (with rail freight corridor no.5) and the North Sea – Baltic Corridor (with rail freight corridor no. 8) (Figure 3).

<sup>&</sup>lt;sup>6</sup> Good – no operational limits; satisfactory – lowered speed or other limitations; unsatisfactory - significant lowering of speed and significant number of other limitations (UTK, 2016b, p. 122).

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Figure 3. TEN-T core network corridors across Poland

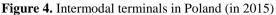
Source: <u>http://ec.europa.eu/transport/themes/infrastructure/doc/ten-t-country-fiches/ten-t-corridor-map-2013.pdf</u> (accessed 10.03.2017)

We need to add that the European Union established special programme Connecting Europe Facility to finance the TEN-T network. For the programme beneficiaries, 11.3 billion EUR in total were allocated for transport-related investments, including 4.3 billion EUR for Poland (Rydzkowski, 2015, p. 179).

#### 2.4. Intermodal Terminals in Poland

One of the basic conditions for the development of intermodal transport is the existence of proper number of intermodal terminals in the country and their spatially optimal distribution. In Western European countries the average number of terminals amounts to 4.2 terminal per 10 000 km<sup>2</sup> of the country's area (in Germany over 4 per 10 000 km<sup>2</sup>, in Belgium over 7 per 10 000 km<sup>2</sup> and in the Netherlands over 11 per 10 000 km<sup>2</sup>. In Poland the said rate totals 1 terminal per 10 000 km<sup>2</sup>. The total number of container terminals used in intermodal services amounts to 31 today (UTK, 2012, p. 10; UTK, 2016, p. 5). They are located rather unevenly on the national scale; however, we can determine three main areas where they are located (Figure 4): the first – on the coast of the Baltic Sea (e.g.: in Gdańsk, Gdynia, Szczecin and Świnoujście); the second – along the area in the central part of Poland (e.g.: near Poznań, Łódź and Warsaw); the third – at Lower and Upper Silesia (e.g.: Brzeg Dolny, Kąty Wrocławskie, Dąbrowa Górnicza and Sławków). In some parts of the country there are no such facilities to provide the national and international services, in particular in the northern and eastern part of Poland.





Source: (UTK, 2016, p. 7)

Among intermodal terminals used to provide services in Poland there are a number of facilities which in terms of their supra-structural equipment (RTG cranes), technical parameters, e.g. (length of tracks with minimal standard ca. 600m – 750m) or yard surface standard, meet Western European standards. These are modern facilities in the Polish seaports, or e.g. the terminal in Kutno. However, a significant number of the Polish intermodal terminals fail to meet Western European requirements making it possible to handle larger flows of containerized cargo. The main problem involves their unsatisfactory technical condition. It refers to: limited handling and storage capabilities; low quality of handling equipment (in many of them reachstackers dominate), low quality of terminal surface and storage yards, poor condition of access roads (UTK, 2012, p. 11-12; Grzelakowski, 2014, p. 16).

Moreover, we need to indicate that in Western Europe e.g. in Germany intermodal terminals, in many cases, constitute the integral part of the logistics centres established, called freight villages. They are multi-entity structures – they include many companies (mainly from TSL sector). In Poland, no plans regarding the construction of such logistics centres were implemented. Therefore the location of the majority of storage facilities without direct access to intermodal terminals limits the possibilities to consolidate the flows of cargo and start regular full train services (Grzelakowski, 2014, p. 16). It is especially important for international supply chain cargo services.

# 3. INTERMODAL SERVICES IN POLAND AND INTERNATIONAL SUPPLY CHAINS

In recent years, the intermodal services in Poland are clearly characterised by dominant services in international transport compared to national services. Taking into account transport output, the share of international services amounted on average to 70.6%, and national services only to 29.4% in recent years (UTK, 2016, p. 11). In order to refer these relations to issues presented in the title of article we need to perform additional analysis. In Poland, due to general conditions, the international supply chain flows of cargo fail to result only from the international trade of the

country. In such case we need to take into account three main<sup>7</sup> groups of factors managing the services:

- Polish international trade services (special attention shall be paid to the main trade partners and their geographical location);

- hinterland services of the Polish seaports to and from selected terminals in Poland and services from Poland to the seaports of Western Europe;

- transit services (mainly east-west and west-east) through Poland.

In recent years, within each of the defined areas we could observe changes contributing to the development of intermodal service market and to influence its specific character. Therefore, each of them were analysed below.

From the economic transformation the volume of foreign trade in Poland has steadily been increasing. Over the last years, it was influenced by the Polish accession to the European Union (in 2004) and the related freedoms of movement, goods, services and capital. Upon analysing the value of trade volume we can observe their rapid development after the accession. Still in 2000 the value of Polish import totalled 48 940 million USD, and export 31 651 million USD. In 2010 the value of Polish import reached 178 063 million USD, and export 159 758 million USD, and in 2015 the values totalled respectively: 197 682 million USD and 200 343 million USD (CSO, 2016, p. 327-328). We need to add that between 2005 and 2015 we could also observe significant increase in the volume of exported goods from 76.6 million tons to 106.1 million tons (Matczak, 2016b, p. 13). When analysing the directions of the flows of cargo within the international supply chains, we also need to pay attention to the main trade partners of Poland. From the 1990s, Germany has ranked first, both in export and in import. In recent years, significant changes have been observed at two subsequent places. It is worth mentioning that for several years China has been an important trade partner of Poland in terms of the import of goods. In 2015, the largest share in Poland's foreign trade volume in terms of import, belonged to the following countries: Germany (22,9%); China (11,6%) and Russia (7,3%), whereas in export they included: Germany (27,1%); Great Britain (6,7%) and Czech Republic (6,6%). In 2014 a group of countries - main trade partners of Poland was identical. The difference in terms of particular places referred only to export: the Czech Republic was second, and Great Britain third (CSO, 2016, p. 562). We can observe the relation between the main trade partners of Poland, and destinations of the majority of intermodal services per month, as for the number of trains provided by the carriers. We need to remember that in Poland ca.<sup>8</sup> 1700 intermodal trains (per month) started operations in 2014. It includes international freight services (export-import) from Poland to Germany (in 2014 - over 260 trains per month), from Poland to Belarus (in 2015 - over 130 trains per month) and from Poland to Czech Republic (ca. 70 trains per month) (UTK, 2016, p. 9-11).

In international services, apart from those related to the Polish foreign trade, we need to pay attention to transit services. As mentioned above, it is related to the location of Poland at the important transport corridors. In transit, from the East to the West, the majority of trains (136) started operations per month from Terespol (eastern

<sup>&</sup>lt;sup>7</sup> For clarity, and due to limited length of the text it was reduced to those recently recognized as the most important.

<sup>&</sup>lt;sup>8</sup> Data for 2014, later comprehensive information on the subject is not available.

border of the country – with Belarus) to Kunowice (western border of the country – with Germany). In total with transit routes to other directions (also to Czech Republic) there were 340 trains (UTK, 2016, p. 11).

We need to emphasize that the potential of Poland to play an active role in transport services from the East to the West and from the West to the East is not sufficiently used. Today, there comes an opportunity to improve the situation. The intensity of services in this direction may contribute to such improvement with the new concept "One Belt One Road" entering into force. The said solution constitutes favourable option for freight transport from China. The land route to Europe is ca. 11 thou. km (its sea route via Suez Canal - 17 thou. km), and the time of transport by land amounts to 12 to 15 days (sea route 28 to 35 days) (PKP Cargo after: Nietz, 2017, p. 29). Poland is located at the land section of that route. Its role should not only involve making railway lines available. With the current state of market development and further infrastructure investments scheduled there is an opportunity to make some of intermodal terminals in Poland operate as hubs where containerized cargo is handled and distributed among trains carrying them further to the west or north of Europe. Many European countries compete for such role for their terminals. One of the locations interesting for the partners from China is Łodź. There, on the area covered by the Special Economic Zone we could have intermodal terminal - dry port for train services from the Chinese city of Chengdu (Nietz, 2017, p. 30).

When we analyse the development of intermodal services in Poland from the East to the West and from the West to the East, we need to pay attention to the terminal in Sławków (near Katowice). It has direct access to the longest in Poland (nearly 400 km) section of wide track (1520 mm), running to the eastern border. It gives the terminal opportunity for further development in case of more services within the new Silk Road. The terminal in Małaszewice located at the eastern border of the country plays an important role for such services (Figure 4). Many terminal operators present their facilities as potential hubs for the trains from China.

The importance of the Polish intermodal market for handling the cargo of the new Silk Road will stem from ministerial contacts and business relations with Far Eastern partners. They include, e.g. initiatives of rail carriers (e.g. memorandum signed by PKP Cargo with the representatives of Xinjang region, where large dry port shall be built) (Nietz, 2017, p. 29). The cooperation is also being established by other entities of intermodal and logistics market, e.g. numerous logistics operators. The rail company managers emphasize that important approach for the future involves establishing business relations resulting in increased cargo export to the East. It would lead to better balance of cargo mass in intermodal services to the Far East (Nietz, 2017, p. 29).

When analysing another direction of services we need to pay attention to the services provided for the hinterland of the Polish seaports. In recent years, they have gone through very rapid development of containerized cargo handling (Table 6). Significant contribution resulted from the construction of Deepwater Container Terminal in the port in Gdańsk, which was opened at the end of 2007. The port is entered by container vessels of the largest shipping alliances (Urbanyi-Popiołek, Klopott, 2016, p. 521). In total in the country, in 2016 maritime terminals handled 2 031 369 TEU (Table 6). Moreover, we need to focus on handling unitized cargo at

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Polish ferry and ro-ro terminals, which amounted to 537 964 freight units in 2015 (Matczak, 2016, p.4).

Tuble of Colli	ruble of Container nandning in the fargest rouble scaports (in The)						
Port	2004	2007	2011	2013	2015	2016	
Gdańsk	43 739	96 873	685 643	1 177 626	1 091 202	1 298 352	
Gdynia	377 236	614 373	616 441	729 518	684 796	642 195	
Szczecin-	27 680	56 276	55 098	78 439	87 784	90 822	
Świnoujście							
Total	448 655	767 522	1 357 182	1 969 451	1 863 782	2 031 369	

**Table 6.** Container handling in the largest Polish seaports (in TEU)

Source: own elaboration of the author based on: (Matczak, Ołdakowski, 2010; Matczak, 2016, p. 4; Borkowski, 2017, p. 34)

The majority of intermodal operators in Poland have in their offer services provided from container terminals located in the Polish seaports (in Gdańsk and Gdynia) with intermodal terminals in the hinterland of those ports. They include e.g.: PCC Intermodal (to: Kutno, Brzeg Dolny, Kolbuszowa, Gliwice), Polzug (to: HUB Gadki, Pruszków, Dabrowa Górnicza), Erontrans (to: Radomsko, Strvków, Poznań), Maersk Polska (to: Katy Wrocławskie, Sławków, Szamotuły), Loconi Intermodal (to: Warszawa, Łódź, Radomsko, Poznań), Spedcont (to: Łodź, Terespol), Baltic Rail AS Rail World Group (to: Siechnice, Włosienica) (Raport, 2017, p. 15,16; Railing Schedule, 2017, 20-21). Although in the reports the services are classified as national services, we need to realize that the transported freight includes mainly cargo in international supply chains. As a result of establishing more connections and participating in the initiatives of more and more entities, the share of intermodal services in container terminal handling in the Polish seaports has steadily been increasing year by year. In 2015, the share in the Polish container terminals exceeded 30%. At present, it increased and, e.g. in the Baltic Container Terminal (Gdynia) in 2016 the share totalled nearly 40%. However, further increase in the handling of containers in the ports of Gdańsk and Gdynia, with today's unsatisfactory condition of road and rail infrastructure leading towards the seaports, may soon result in significant difficulties in collecting and delivering the containerized cargo. In this context, an important initiative includes the construction (by PCC Intermodal) within dozens of kilometres from those ports - Intermodal Container Yard. The scheduled annual handling capacity of the terminal shall amount to 1 million TEU (PCC Intermodal, 2017).

As mentioned above, the hinterland intermodal services are also provided from the terminals located in the western part of Poland to the ports of Western Europe. Such connections are serviced mainly by the same operators who handle the hinterland of the Polish seaports. The service providers include, e.g.: Hupac (to: Duisburg), PCC Intermodal (to: Rotterdam, Hamburg), Erontrans (to: Rotterdam) (Raport, 2017, p.15). The important connection here is: Swarzędz (near Poznań) – to Rotterdam (22 trains per month) (UTK, 2016, p. 11). There are also regular connections from Poland to the port of Koper Luka (Slovenia), provided by Baltic Rail AS Rail World Group (Raport, 2017, p. 15).

# 4. CONCLUSIONS

The contemporary international division of labour and tendency to implement offshoring strategy increase the role of freight carriers on a global scale. The majority of countries worldwide operate today within the international supply chains and large flows of cargo are transported globally. Poland, with access to the Baltic Sea and modern container terminals, takes active part in handling these flows from the North to the South and from the East to the West, but the crucial role belongs to intermodal transport. The conducted analysis makes it possible to determine that the Polish intermodal market in many areas harmonizes and in many differs from the solutions and standards characteristic for the Western European countries. Modernization is necessary as well as the development of linear and nodal infrastructure of rail transport, replacement of rolling stock, and rationalization of track access charge. Moreover, we need actions taken by various groups of entities related to intermodal markets and their cooperation (e.g. representatives of ports, rail carriers and intermodal operators). Negligence, even if in one of the areas defined in the article, may not only have adverse effects on intermodal market but also threaten various aspects of the competitiveness of Polish economy and marginalize the importance of entities from Poland within the international supply chain system. It may prove hazardous, e.g. for the competitive advantage of Polish seaports. The increasing flows of containerized cargo will not be quickly transported to the hinterland, which will adversely affect the effectiveness of activities. The said fact may result in clients choosing the ports of Western Europe. In the transport from the East to the West there is also real threat of losing the flows of cargo. If, at the right moment, the infrastructure or carriers are not ready to take active part in servicing the new Silk Road, the transported cargo will bypass Poland since entities from other countries are eager and ready to render the services.

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# THE ROLE OF CONSUMER INVOLVEMENT IN OPTIMIZING THE ELECTRICITY SUPPLY CHAIN - SMART GRIDS, SMART CARS, SMART CONSUMERS?

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#### Abstract

The electrification of personal, public and commercial transportation is considered as one of the possible solutions to challenges such as global warming, sustainability, and the limited availability of fossil fuels. The integration of electric vehicles into the electricity portfolio present many challenges, but also opportunities to the operation and planning of the electricity supply chain. The supply chain of electricity is a unique one of its kind; not only because of the fixed distribution routes and strictly pull strategy, but because the end consumer has the option to directly contribute to the chain as a producer/wholesaler/system influencer as well. This study investigates consumer attitude towards incentives supporting electric car usage, and towards the promotion of active consumer involvement for electric car owners as contributors in supply chain optimization. Research was conducted in central Hungary (N=211), and results indicate that given the sufficient amount of state support and concrete consumer benefits, consumers have the willingness to cooperate with smart grids whilst creating a more balanced, more stable and more efficient electricity supply chain.

Keywords: consumer involvement, electric cars, smart grid, supply chain optimization

#### **1. INTRODUCTION**

Local and global businesses, as well as consumer energy systems getting more dependent on electric networks is a tendency worldwide (Veres, 2014). Besides classical, fossil-fuel power stations and nuclear power plants, renewable energy The role of consumer involvement in optimizing the electricity supply chain - smart grids, smart cars... Noémi Piricz, Péter Bajor, Csilla Fejes

sources also feed the electric networks in order to satisfy constantly growing consumer needs. Increasing energy efficiency is one of the top priorities of the European Danube Region Strategy (European Commission, 2010) and the Paris Agreement, while the improvement of energy networks on a national level is of key importance for countries; not only to increase the security of energy supply but also to support macroeconomic competitiveness. As consumers are getting more dependent on electric networks as never before, they have certain expectations towards electric power services. They want electricity to be affordable, clean, reliable and capable of supporting both the evolving economy and society (Sioshansi, 2011). Energy efficiency aims to reduce the amount of energy required to provide products and services (ISO 17743:2016), while worldwide energy demand is predicted to grow with an average annual growth rate of 1.6% until 2035 (International Energy Outlook, 2016). While the number of energy consumers and the amount of consumed energy is constantly growing, the electricity supply chain struggles with the lack of storage and balancing opportunities within the system. This paper focuses on the role of consumer involvement in optimizing the supply chain using the storage capacity of electric car batteries, and on the willingness of consumers to cooperate with system operators. We investigate if, and if so, how and to what extent individual users are ready for cooperation and whether or not they are willing to sacrifice their freedom to some degree in order to have a trustworthily operating and sustainable national electric supply system. Therefore, our research questions are the following:

- 1. What is the individual users' opinion and approach if their freedom of driving range and charging access becomes limited? Are they ready to give up on their freedom for figurative or indirect advantages? If so, what do they expect in return?
- 2. Where and how do they require state support? What kind of support or offset could they accept?
- 3. What do people think of electric cars as energy storage facilities? Are customers aware of their role as potential system influencers? Are they open and able to fulfill this new role and expectation?

### 2. ELECTRICITY IN THE 21<sup>ST</sup> CENTURY: THE SMART GRIDS

As electricity demands increased through the late twentieth century, system operators and power generators have searched for ways of managing peak loads. The costs of building and maintaining capacity to handle peaks — capacity which would not be used during long periods of non-peak load — led system operators to study their demand periods, price them accordingly, and to encourage customers to switch consumption from peak to non-peak periods. The goal was to match consumption to generation, and it required meters, which could measure the time of day of the consumption in addition to the cumulative consumption. Automatic meter reading devices introduced in the 1970's were the beginning of meters, which provided information back to the utility, a basic requirement of any smart grid system. Smart grids are "automated, widely distributed energy delivery networks characterized by a two-way flow of electricity and information, capable of monitoring and responding

to changes in everything from power plants to customer preferences to individual appliances" (IEEE, 2011).

What makes a grid smart? According to Amin and Giacomoni (2015), smart grids are self-healing systems that empower and incorporate the consumers, tolerant of attack, provide power quality needed by 21st-century users, accommodate a wide variety of supply and demand, and are fully enabled and supported by competitive markets. As seen on Figure 1, smart grids are complex networks, and usually include a wide variety of operational and energy measures including smart appliances, renewable energy resources, and energy efficient resources (Saleh et al., 2015).



Figure 1. The smart grid supply chain

When thinking about electricity, it may seem that the product of a power station is the alternating current power that travels from the power plants straight to the consumer's home. However, the real product provided by this supply network is not simply electrical energy, but the availability of electrical energy - whenever and wherever consumers need it. The main function of the electricity supply is to serve the consumer demand with solidly available (security of supply) and satisfactory (quality of supply) electrical energy (with adequate frequency and voltage), on as low full costs as possible (Bajor, 2008).

National and worldwide energy networks bear every trait of a traditional supply chain: they are integrated networks between various producers with different transmission stages until the product reaches the final consumer (Hofbauer, Wenninger, 2011). In order to reach the right customer at the right time with a right amount and right quality of energy, system operators perform supply chain management tasks like network design, production planning, order management, sales and operations planning, collaboration with suppliers and customers and many other processes to successfully plan, operate and manage this worldwide supply chain.

Compared to traditional supply chains, the electricity chain has many unique features. The chains usually operate under strong state influence, are often vulnerable to changes in national politics, and - despite being interconnected - mostly operate on national markets. Moreover -as demonstrated on Figure 2-, the supply chain of electricity is partly or fully a natural monopoly, where giant power generators, transmission or distribution companies dominate the markets.

Source: http://www.edsoforsmartgrids.eu/home/why-smart-grids/

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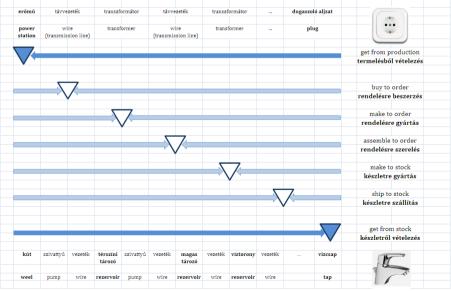
Figure 2. Layout of the Italian electricity supply chain

Prices are influenced by many factors: geological, political and economic environments, the proportion of renewables in the portfolio, and vary significantly - from 0,308 Euro/Kilo Watt hours (KWh) in Denmark to 0,065 Euro/KWh in Serbia (Eurostat, 2017) - from country to country within Europe.

From the viewpoint of conventional logistics, the electricity supply is a typical pull system, without significant storage possibilities at the final product level. Power plants and other generators produce the required electrical energy from moment to moment, otherwise the system loses its balance, and the service breaks off – generating high balancing costs and enormous costs of restarting (Bajor, 2007).

Comparing the supply chain of electricity to the supply of water (see Figure 3.) highlights the main differences between a push (water) and a pull (electricity) system.

Figure 3. Comparison of the supply chain of water and the supply chain of electricity



Source: Bajor, 2014

Source: http://eng.gruppohera.it/group/business\_activities/business\_energy/electricity/

While the supply chain of water incorporates several storage facilities (reservoirs, water towers, etc.) and pushes – in this case, pumps- the product directly to the customers who get their water from already available stock, the electricity chain works differently. Due to the very limited options for storing electricity, the chain operates with a variety of protective capacities – power plants with different physical abilities and different price-regulations –to ensure the availability of compensating backup-resources. In the case of water, the product is waiting in the place of use for the consumer who only needs to open a faucet, while in the case of electricity, the consumer gets electricity straight from production by switching on the light.

# 3. THE IMPORTANCE OF STORAGE IN OPTIMIZING THE ELECTRICITY SUPPLY CHAIN

In a pull supply chain, procurement, production and distribution are demanddriven rather than to forecast. Toyota Motors is frequently used as an example of pull production, yet the company follows the "supermarket model" where limited inventory is kept on hand and is replenished as it is consumed (Ohno, 1988). In the electricity supply chain, the availability of these safety inventories is highly limited, thus making the supply chain vulnerable to unforeseen events or sudden changes in demand. While options like hydroelectric pumps, batteries, flywheels, compressed air, thermal energy and hydrogen are all used in storing electricity, their production and operation is expensive and their availability is limited (Energy Storage Association, 2012). The United States, the world's second largest energy consumer has around 0,023 TW of storage capacity (of which 96% is generated by hydroelectric energy), while the average daily consumption is more than 11,35 TWh (Electric Power Annual, 2015). Storage in the electricity supply chain has many important functions, like providing resource transfer (TRN), networks savings (ISS) and kinetic advantage (KIN) (see on Fig. 4).

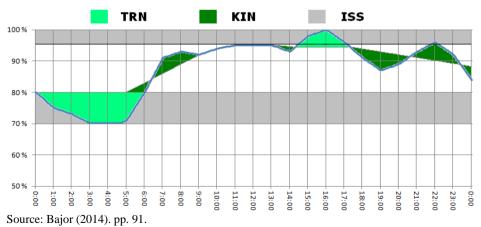


Figure 4. The role of storage in electricity supply

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While energy storage is a great possibility by itself, the electricity of electrical energy cannot be stored, or just in limited ways and amount. Electricity must be used as it is being generated, or transformed to another form immediately. This means that the system has losses in the process of transformations, but these losses are mostly inferior to the losses of other processes, which operators apply to regulate the system (Papp, 2015). Due to this condition, we believe that the behavior of all actors – including consumers- in a smart grid may become vital.

# 4. THE ROLE OF ELECTRIC CARS AND ELECTRIC CAR OWNERS IN STORING AND BALANCING ELECTRICITY

According to several researchers, with the emergence of technologies like plugin hybrid (PHEV), fully electric (EV), vehicle-to-grid (V2G) and grid-to-vehicle (G2V) vehicles, the storage and management of electricity could better be secured (Hannan et al, 2017; Putrus et al, 2015; Gennaro et al, 2014). One of the biggest obstacles in electric car penetration has always been the price of the battery, which takes up a significant amount of 30-40% of the total retail price. In 2010, 1 KWh of electric car battery cost \$1000, with predictions that by 2020, it can decrease to around \$225. In 2017, 1 KWh of electric car battery costs \$195, and predictions believe it may drop a further 40% in the upcoming year (Institute for Energy Research, 2016).

EV batteries have considerable energy storage capacity (from 20 up to 100 kWh) that can be used in various ways to balance high and low demand periods, or even to upload electricity to the grid when it is needed. Controlled charging allows a schedule whereby EVs can be charged at a time when the grid has surplus capacity (e.g. surplus renewable energy) and discharged when the grid has a shortfall in capacity (Putrus et al, 2015). Smart chargers allow consumers and system operators to control the output (charging rate and time) based on grid state (available power) and EV user requirements, while EV aggregators are able to aggregate supply and demand for electricity in EV batteries and to intermediate transactions between the different consumers of V2G and G2V services (Niesten et al 2016). Vehicle-to-grid (V2G) electric vehicles can return power stored in their battery back to the power grid and be programmed to do so at times when the grid needs to reserve power. Since providing this service can lead to payments to owners, it effectively reduces the lifecycle cost of owning an electric vehicle (Parsons et al, 2014) (Hannan et al, 2017).

According to a research conducted by Pwc Hungary in 2015, the number of electric cars is predicted between 53,000 (realistic scenario) and 140,000 (optimistic scenario) by 2023. Calculating with an average battery capacity of 50 kWh, the storage capacity controlled by electric car owners will be around 2,65-7 GWh, which represents 2-5% of the predicted average daily electricity consumption in Hungary (Pwc, 2015).

While an overall proportion of 2-5 % is not high, and does not require the integration of additional generators or power plants into the system, considered as a storage capacity and system-balancing tool, 2-5% of additional storage could be a significant factor in the Hungarian electricity supply chain. Due to its geographical location and characteristics, hydroelectric pumps can not be installed and cannot be

operated effectively in Hungary, therefore, 2-5% of storage could eliminate many risks and - with appropriate consumer involvement - could be an effective tool in managing the peaks and valleys caused by the fluctuation of daily energy demand.

According to Lo Schiavo et al (2013), 80 % of the EV recharging activity will take place at home, out of convenience. This requires relevant technological and infrastructural developments and improvements in both households and in energy networks, and a certain amount of orderliness and discipline from the consumers. There are several options of cooperation for EV drivers, such as smart batteries and chargers operated by system operators, scheduled charging, uploading electricity to the grid when needed, and others (Yu et al, 2014). Co-operations with the supply chain are regulated by contracts between the parties, and usually provide benefits for cooperating consumers. Consumer benefits vary from country to country, and may include tax credits, exempt of VAT or registration tax, free or discounted parking, the possibility to use carpool lanes or public transport with a discounted price, reduced electricity prices and other state funds. The purpose of incentives is to persuade electric car owners to take part in the optimization of the electricity supply chain by deliberate and scheduled charging or energy uploading.

Hungary currently has approximately 15,000 electric cars, but the regulation and incentive system is still in the developmental phase (Central Statistics Agency, 2016), therefore future owners are not fully aware of all incentives or of the possible ways of cooperation. The next chapter investigates the attitude of potential electric car buyers towards the existing incentive system, the expected benefits and the willingness of electricity consumers to cooperate with the chain as electric car owners.

#### 5. RESEARCH METHODOLOGY

As a research methodology, respondent-driven, or snowball sampling was applied in the preliminary phase. First, a group of respondents (correspondence students at Dunaújváros University of Applied Sciences, Hungary) were chosen then respondents recruited further subjects from among their acquaintances who fulfilled the questionnaire online (N=211). The other group of chosen respondents have a residence in a 40 km radius of the city of Paks, which is the flag-bearer city of Hungarian e-mobility. Hungary's only nuclear power plant is located just outside the city, and both local and national governments are working on transforming Paks into the first Hungarian city equipped with a complete electric transportation infrastructure. Because of the proximity of the nuclear power plant, perceived income and general knowledge on vehicle-to-grid (V2G) and grid-to vehicle (G2V) technologies were expected to be higher than the Hungarian average. Generally, we can say that our respondents originate from middle Hungary.

As snowball sampling is usually applied to locate and identify specific or hidden groups in population, this research method enabled to study a group of people, who based on their geographical location and perceived high income - might be interested in purchasing electric cars and in contributing to the optimization of the national electricity network. Applying snowball sampling, however, also limited the research, as with this sampling technique, it is impossible to determine the sampling error or make inferences about populations based on the obtained sample. Another limitation is that most respondents were located in central Hungary, and results might be different if sampling was made throughout the country.

#### 6. RESEARCH RESULTS

Based on the theory of Diffusion of innovations by Everett Rogers, electric cars with their complex infrastructure belong to the group of innovative products, therefore their current Hungarian buyers are so called early adopters who "are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters" (Rogers, 2003). The results of this research confirm Rogers' theory, as the 70% of the respondents are between 25-45 years old, and 73,8% of them have at least a Bachelors' degree.

As expected initially, the financial conditions of the respondents are above the Hungarian average, as Paks region has the 9<sup>th</sup> highest income in Hungary. While the average net salary in the Hungarian administrative sector in 2016 was around EUR 500 and around EUR 580 in the private sector (Hungarian Central Statistical Office, 2017) the respondents' net income is mostly either between EUR 645-1000 or above EUR 1000. This is an important factor regarding e-mobility, as electric cars are still relatively expensive vehicles.

According to a representative survey of Robert Bosch Hungary conducted by Medián Public Opinion and Market Research Institute, 44 % of the Hungarian families had at least one car in 2016, and the average car owned by Hungarian households was 13,2 years old (Bosch Media Service Hungary, 2016). Average Hungarian buyers seek used petrol cars up to EUR 7,000, similarly, the respondents of this research mostly prefer used cars (72%), and 33% of them plan to buy - preferably used - cars in the next 2-5 years. Despite the financial limitations, respondents are open to and aware of new, environmental friendly ways of transportation, as 98% of them stated they are familiar with hybrid, 88,2% with electric, and 74,4% with plug-in hybrid cars.

Before investigating the respondents' attitude towards electric cars and offered incentives for electric car users, the most important factors influencing car-buying behaviors were reviewed – as a measurement tool, 5-point Likert-scales were used. As seen on Figure 5, respondents indicated 'safety and reliability' of the car as the most important. Despite the fact that respondents mostly seek relatively cheap and used cars, fulfillers indicated environmental impact as the second most influential factor considered before buying a car. While the number or conscious consumers has grown significantly, Hungarian individual buyers became more deliberate (the size of the market of electric cars has tripled in size between 2014-2016) (GfK Research, 2017), individuals participating in this research also consider the cost-benefit ratio and consumption and cost of maintenance as highly important.

While the amount of money respondents are planning to spend on their next car (around EUR 3225-12900) is relatively low, 14,8% of the respondents stated they would buy a hybrid or pure-electric car as their next vehicle, while 36,2% would consider buying an electric car given the sufficient amount of state support or additional benefits.

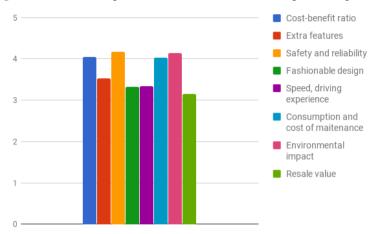
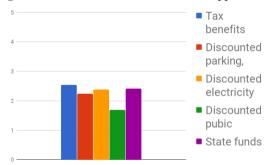


Figure 5. The most important factors considered before purchasing a car

Source: own study

According to respondents, the most favored state aids provided for electric car users are tax benefits, various state funds, and discounted electricity prices, while discounted parking and public transport are less appealing, but still attractive options (see Figure 6). Currently, the state funds provided by the Hungarian government cannot be higher than EUR 3,000 or 21% of the retail price of the vehicle.

Figure 6. Favored incentives and state-supplied benefits of electric car ownership



Source: own study

Regarding the main, perceived benefits of electric cars, respondents believe that the biggest benefits are the low fueling costs and the greener households, while tax benefits, low maintenance costs and expected price reductions are less attractive options (see Figure 7). In Hungary electric fueling is free and currently this is the largest state support. Fortunately there more and more fueling points throughout the country therefore we can find more electric stations in Budapest and at least one in towns as well. So this benefit is quite natural and expected. Environmental consciousness has been developed in Hungary and this aspect may explain the found The role of consumer involvement in optimizing the electricity supply chain - smart grids, smart cars... Noémi Piricz, Péter Bajor, Csilla Fejes

second important benefit. Respondents rated prestige as the least favored benefit of an electric car ownership.

As chosen respondents (and many of their acquaintances) originate from and around Paks (the city where the Hungarian Nuclear Power Plant is located), both income and knowledge of this field are above national average.

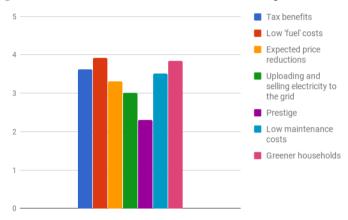


Figure 7. Perceived benefits of electric car ownership

When identifying the barriers of electric car penetration, there was no consensus among respondents. As seen on Figure 8, respondents had to prioritize what they considered as the most or least influential factors preventing electric car penetration – it has been confirmed that respondents consider all investigated factors as important barriers. These results indicate that further details and aspects should be investigated, possibly through qualitative methodologies.

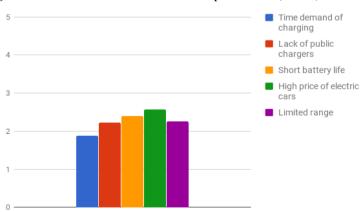


Figure 8. The main barriers of electric car penetration (means)

Source: own study

Source: own study

When it comes to accepting the interference of system operators and smart solutions into charging and availability, 44,2% of the respondents believe they would be able to accept the limitations of the system (charging when electricity demand is low, and uploading energy when electricity demand is high) if the government or actors of the supply chain would offer concrete, measurable benefits in return. 17,5% of the respondents believe, that the supply chain can only be balanced with direct and centralized control over charging, and they state they would contribute to this effort if they owned an electric or plug-in-hybrid vehicle. Out of 211 respondents, only 38 (18,4%) stated that they would categorically not give up their freedom of constantly available, unlimited range (fossil-fuel vehicles), as their lifestyle or travelling habits require them to be available at any time, in any range. Based on the results of international researches (eg. Parsons et al, 2014) this level of consumer support is surprisingly high and needs further investigation and validation.

## 7. CONCLUSIONS

The emergence and penetration of electric cars and the related technological potential raise a number of questions – on both national and on a worldwide level. Will this technology be greener, smarter, more sustainable and effective in reaching goals like energy efficiency and conscious consumption of electricity? Based on our research, we can say that it strongly depends on the consumers: their behavior, attitude and perceived role in the electricity supply chain. Based on this research, we can say that in order to balance, operate and control the uncertainties of the electricity supply chain, the active and deliberate involvement and cooperation of electric car users is inevitable.

Preliminary results of this research are encouraging, as respondents claim they are open to the provided possibilities of this new technology, however, some results are contradictory and require further and deeper – possibly international-investigation. Contradictory results – like importance of environmental impact vs. money spent on cars, or the willingness of using electric cars vs. intended amount of money spent) may also be a result of direct or indirect social pressure or lack of information, and also need further investigation.

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# DELIVERY RELIABILITY IN OUTBOUND VEHICLE DISTRIBUTION – A FACTOR OF SUCCESSFULL AUTOMOTIVE SUPPLY CHAIN

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#### Abstract

Finished vehicle logistics is a complex activity focusing on outbound delivery accuracy and quality in the automotive supply chain (outbound vehicle distribution). Once the vehicle has been produced, it is transported from production plant to the dealership via outbound logistics. The most important criteria that reflect performance of successful automotive outbound supply chain are among other: on-time pickup, delivery reliability, lead time, dwell time and damage-free delivery (damage level). Therefore, the objective of this paper is to analyse delivery reliability as crucial factor of successful vehicle logistic provided by logistic service providers (3PL, 4PL or LLP). They play an important role in rising of efficiency in a complex automotive supply chain as outsourcing partners of original equipment manufacturers (OEM's) and evaluate their performance using Key Performance Indicators (KPIs) from which is the most important: on-time delivery (OTD) as indicator of delivery reliability. Premium segment of the automotive industry is creating optimised supply chain that realize short delivery times and high delivery reliability in order to maximize customer satisfaction. In formulating and analysing the research problem, the authors explore performance using Key Performance Indicators (KPIs). The findings indicate that continuously measurement of on-time delivery can improve overall automotive supply chain and fulfilment of customer requirements.

**Key words:** finished vehicle logistics, delivery reliability, outbound distribution, Ontime delivery, key performance indicator (KPI)

### **1. INTRODUCTION**

Outbound vehicle distribution is of crucial importance for an efficient automobile supply chain and impacts on customer satisfaction. There are many criteria that reflect a performance of successful automotive supply chain and most important are among other: on-time pickup, delivery reliability, lead time, dwell time and damage-free delivery (damage level). Delivery reliability is one of the main determinants in automotive logistics that means ability to deliver logistics service when promised. Therefore is essential component of this research.

The aim of this paper is to analyse the delivery reliability as crucial factor of successful vehicle logistic provided by logistic service providers (3PL, 4PL or LLP) which play important role as outsourcing partners of original equipment manufacturers (OEM's).

In analysing and formulating the research problem, the authors used different combinations of scientific methods such as: the classification and comparative method, the method of deduction and induction, the method of description and the method of analysis and synthesis.

The paper is organised in five chapters. After *Introduction*, the second chapter titled *The main characteristics of automobile supply chain (outbound vehicle distribution)* introduces the main characteristics of complex supply chain in channel of finished vehicle logistic that includes also intermediaries and third-party service providers. *Key performance indicators (KPI's) – tools for improving and optimising outbound supply chain performance* focuses on main KPI's in a post-ante context in order to evaluate the past performance of a logistic service providers. Forth chapter is focused on *delivery reliability* and definition of delivery window as a framework for managing delivery performance. In *Conclusion*, the synthesis and explanation of the results of this research are given based on the collected information and data.

#### 2. THE MAIN CHARACTERISTICS OF AUTOMOTIVE SUPPLY CHAIN (OUTBOUND VEHICLE DISTRIBUTION)

The Council of supply chain management professionals defines supply chain management (SCM) as encompassing, the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (CSCMP, 2013, p.1). They define outbound logistics as processes related to the movement and storage of products from the end of the production line to the end user.

Outbound vehicle distribution are vehicle logistics services provided after they have left the production plants to go to dealers or importers. The vehicle distribution network of an automotive company consists of all activities required to deliver finished vehicles from the assembly plants to the dealers (Eskigun et al., 2005, p. 182).

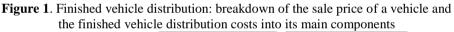
The automotive industry is the world's largest single manufacturing activity. It uses 15 percent of the world's steel, 40 percent of the world's rubber and 25 percent of the world's glass. It also uses 40 percent of the world's annual oil output. Vehicle distribution or outbound logistics is the process of transporting vehicles from the assembly plant to the dealership or final customer with large fleets. The outbound distribution logistics is always done via train, truck and ship (Suthikarnnarunai, 2008, p. 1-3).

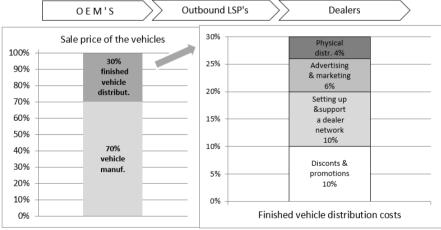
The researches on outbound logistics related activities include transportation mode selection and customer satisfaction through lead-time reduction (Eskigunet et al. 2005, Miranda & Garrido 2004, Chopra 2003), optimum location of distribution centres (Wasner & Zapfel 2004, Nozick 2001, Melkote & Daskin 2000), shipment consolidation (Tyan et al. 2003, Cetinkaya & Bookbinder, 2003). Therefore, most of the existing literature focuses on the vertical collaboration in outbound logistics systems. According to Bowersox et al. (2003, p. 18), the essence of horizontal collaboration is to jointly develop strategic plan and synchronize operations to achieve economies of scale, reduce or eliminate duplication and redundant operations.

Each automotive OEM operates its own outbound logistics network. The outbound logistics operations form the last step of the three main processes: order receiving from the dealers, manufacturing vehicles at the plants, and transporting finished vehicles to the dealers (Nazmul, 2012, p. 25).

Outbound vehicle distribution from the OEM vehicle assembly plant to dealer has influence on effectiveness of the overall supply chain by representing the lead time to customer which is interested when vehicle will be delivered. "Proportioning between manufacturing lead-time and distribution lead-time means little; customers only want to know when the merchandise will arrive." (Miemczyk & Holweg, 2004, p.5).

The review of the literature showed also that physical distribution of finished vehicles typically accounts for 4% of the sale price of the vehicle (figure 1.) and total finished vehicle distribution cost accounts for 30% of the sale price of the vehicle.





Source: European Car-Transport Group of Interest (ECG), 2010, p.51

Therefore, for all automakers, selection of an logistics service providers (LSP's) plays important role and have very high significance in terms of making the outbound supply chain as cost-efficient as possible. They are logistics intermediaries who on behalf of the automotive OEM's arrange logistics services. The outbound logistics

Delivery reliability in outbound vehicle distribution – a factor of successfull automotive supply chain *Robert Bašić, Helga Pavlić Skender* 

process flow begins with release of finished vehicle from the assembly plant and ends with the arrival of the vehicle to the dealer. Of course, some of the vehicles are delivered directly (eg. by truck), and other after arrival by vessel or rail to mixing centres or HUB's, where are consolidated from different plants. The aim of using such intermediaries/LSP's is to facilitate the logistics operations related to the deliveries of the vehicles.

Key skills of outbound logistics service providers in the automotive value chain are:

- a) Ability to reduce lead time
- b) Cost reductions
- c) Effective management of volatile OEM's forecasts
- d) Productivity and quality
- e) Damage control
- f) Ability to respect dealership requirements.

According to Pavlić Skender, Host and Nuhanović (2016, p. 22) "An intermediary is a person or a company that acts as a mediator between different parties with the goal of achieving a certain business deal. Most commonly, intermediaries specialize in one specific field among the various logistics function". In outbound vehicle supply chain are mostly involved three different types of intermediary; third-party logistics (3PL), fourth-party logistics (4PL) and so called lead logistics providers (LLP's). The following table shows the main characteristics and comparison of all types of mentioned providers.

3PL	4PL	LLP	
Logistics managed	Full SC services	Full SC services	
model	including 3PL	incl. Resource	
incl.	basic functions,	management,	
transportation,	Infor. Techn.	Information Central	
inventory	services, and	System, and	
management and	Business	Logistics	
freight forwarding	Process Manag	synchronization.	
Logistics specialty	SC alliance	Managing internal	
services focus on	leading, single	and external	
transportation and	point-of-contact	logistics to	
warehousing	integrated	synchronize	
operation	service	material flow	
Possession of	Outsourcing	Outsourcing	
facilities and			
warehouses			
Possession of fleet	Outsourcing	Outsourcing	
Not applicable	Develop and	Develop and	
	provide IT	provide IT	
	services		
_	Logistics managed model incl. transportation, inventory management and freight forwarding Logistics specialty services focus on transportation and warehousing operation Possession of facilities and warehouses Possession of fleet Not applicable	Logistics managed modelFull SC services including 3PL basic functions, Infor. Techn. services, and Businessinventoryservices, and Businessfreight forwardingProcess ManagLogistics specialty services focus on transportation and warehousing operationSC alliance leading, single integrated servicePossession of facilities and warehousesOutsourcingNot applicableDevelop and provide IT	

**Table 1.** Comparison for different logistic service providers (LSP's)

Source: Huang et al., 2010, p. 168

Third-Party Logistics Providers (3PL) are organisations which provide multiple logistics services for use by customers. According to the Terms and Glossary of Supply Chain Management (2013) third-party logistics provider is a firm which provides multiple logistics services for use by customers. Preferably, these services are integrated, or "bundled" together by the provider. These firms facilitate the movement of parts and materials from suppliers to manufacturers, and finished products from manufacturers to distributors and retailers. Among the services which they provide are transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding.

Fourth-Party Logistics (4PL) according to Supply Chain Management (2013), differ from third party logistics in the following ways:

1) 4PL organization is often a separate entity established as a joint venture or long-term contract between a primary client and one or more partners;

2) 4PL organization acts as a single interface between the client and multiple logistics service providers;

3) All aspects (ideally) of the client's supply chain are managed by the 4PL organization; and,

4) It is possible for a major third-party logistics provider to form a 4PL organization within its existing structure.

In outbound vehicle logistics, the 4PL service providers do not own any physical assets or only limited (such as information technology system) and play a different role, and that is the main difference with 3PL service providers (as shown in figure 2). According to Win (2008, p. 677), the main function of a 4PL provider is to implement and manage a value creating business solution through control of time and place utilities within the client organisation.

A Lead Logistics Service Provider is similar to a 4PL with a different business model in where the LLP manages the transport solution on behalf of the customer but where the actual contracting is carried out by the customer. Actually, LLP is a nonasset based 3PL provider which manages, designs and aggregates outbound supply chain in finished vehicle logistics. Delivery reliability in outbound vehicle distribution - a factor of successfull automotive supply chain Robert Bašić, Helga Pavlić Skender

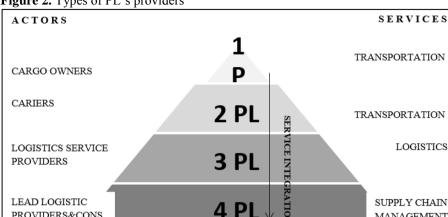


Figure 2. Types of PL's providers

Source: International 3PL, 2015.

LOGISTICS SERVICE

PROVIDERS

LEAD LOGISTIC

PROVIDERS&CONS.

According to results of research of logistics service providers in Croatia (Bašić, 2015, p. 17 - 18), in finished vehicle logistics in v. 2014., 62,59% of brands (new vehicles) are distributed from production plants to Croatian vehicle logistics centers (VLC's) supported by LLP, 30,32% by 4 PL, and 7,09% by 3 PL companies. In the second part of this outbound vehicle supply chain (distribution of vehicles from vehicle logistics centers to Croatian dealers), 82.06 % of brands (new vehicles) are distributed by 3 PL's, 10,87% by 2 PL's and 7,09% by LLP's.

3 PL

4 PI

SUPPLY CHAIN INTEGRATION

LOGISTICS

SUPPLY CHAIN

MANAGEMENT

≻

### 3. KEY PERFORMANCE INDICATORS (KPI's) - TOOLS FOR IMPROVING AND OPTIMISING OUTBOUND SUPPLY CHAIN PERFORMANCE

Logistics operations are complex and the parameters are difficult to measure. Whatever is monitored can be measured and whatever is measured can be improved. It means, areas for improvement can be easily revealed if there is any method that measures logistics function (Kumar, 2013, p. 2). Logistics performance measurement plays a vital role in today's business management. Supply chain performance indicators are key tools for monitoring and improving the supply chain performance to gain competitive advantage (Taylor, 2004, p. 173). Using indicators for the measurement of SCM performance creates an understanding of the supply chain's processes, guides collaboration efforts and optimises supply chain excellence (Fawcett et al., 2007, p. 409).

According to Cox et all. (2003, p. 142) KPI's help an organizaton define and measure progress toward organizational goals. KPI's are quantifiable measurements to examine the improvement in performing an innovation implementing activity that is critical to the success of a business. A KPI has a lifetime and requires continuous updating. Sometimes, its replacement is also needed (Ghalayini & Nobel, 1996, p. 64). According to Sinclair and Zairi (1995, p. 50) KPI's use a metric for quantitatively assessing performance regarding the needs and expectation of stakeholders, the achievement of goals, and reflecting the critical success factors.

In finished vehicle logistics are often used key performance indicators (KPI's) in a post-ante context to evaluate past performance of logistics service providers related to deliveries of vehicles. Because of small margins in outbound vehicle logistics, LSP's continuously trying to find opportunities which can improve their profitability. The most important activities to achieve it, are planning and control for which is necessary to select appropriate indicators and metrics for measuring of performance.

The basic solution in SCM which consist of a lot of measures (factors) is the Supply Chain Operations Reference (SCOR) model. It is developed by the Supply Chain Council (CSCMP) in 1996 and focuses on the supply chain management function from an operational process perspective and includes customer interactions, physical transactions and market interactions. CSCMP (2013, p. 187) emphasize that SCOR model is built around six major processes: plan, source, make, deliver, return and enable. According to Zhou et al. (2011, p. 332) the benefits of implementing the SCR model included faster cycle times, less inventories, improved visibility of the supply chain, and access to important information in a timely fashion. Richey et al. (2010, p. 237) suggested that the supply chain governance which balances the self-interest and independency in supply chain can help improve performance.

The latest trend in automotive logistics, outsourcing require a holistic measurement of performance (Neto & Pires, 2012, p. 734), and provide a rationale for focusing on logistics performance measurement (Gunasekaran et al., 2005, p. 523), too, due to increasing relevance of logistics.

Performance indicators that have an impact on operational performance of logistic service providers in supply chain of outbound vehicle distribution are:

## 1. Transport performance

a) Pick up performance (on time pickups /order to gate out) – calculation method: total number of vehicles picked up within the specified leadtime / total number of vehicles picked up.

Pick up time = shipping date – notification date

- b) Transit time (gate-out to delivery) calculated by the number of days or hours from the time when a vehicle leaves production plant to the time it arrives to destination
- 2. Quality performance

Damage performance – calculation method: damage rate = total of number claims accepted by the carrier / number of vehicles transported

3. EDI performance

EDI on time report – calculation method: number of reported vehicles sent in the lead-time / total of reported vehicles. Transportation lead time is the in-transit interval from customer order to delivery of vehicles to the requested destination.

Using KPIs in finished vehicle logistic ensures evaluating of outbound vehicle distribution against a static benchmark. In case of fluctuations they can indicate that performance moves in the wrong direction and which corrective action can be taken

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to improve the situation. Therefore, KPI's are essential tools for improving and optimising performance of outbound supply chain. OEM's in automotive industry precisely define in contract with LSP's service level agreement (SLA) in which are contained performance measurement indicators and also penalties that being applied when performance falls below contracted levels.

#### 4. DELIVERY RELIABILITY

One of the main parameter which defines the performance of a logistic system is its reliability (Blanchard, 2004, p. 102). Delivery reliability is defined as number of products delivered on confirmed delivery date divided by number of products ordered (Schönsleben, 2016, p. 46). According to Pegels (2005), delivery reliability is the ability of the company to deliver on or before the promised scheduled due date. A high standard of delivery reliability is crucial success factor in achieving customer satisfaction. According to Berry et al. (1991, p. 364), delivery reliability is sometimes referred to as dependability or on-time delivery and concerns the ability to deliver according to a promised schedule or plan. This sub dimension of operational performance is often regarded prerequisite.

Delivery reliability in outbound vehicle logistics means that vehicles are delivered on time. Commonly used measure of reliability is on-time delivery (OTD) that OEM's find by dividing of orders delivered on time by the total number of orders delivered which have goal to achieve ratio of 100%. For optimal performance of the outbound vehicle supply chain is very important that all vehicle logistics processes are harmonically synchronised because higher operating efficiency results in shorter lead time and improve on-time delivery performance that leads to decrease of delivery cost as well as total cost. When delivery is made on time, the costs incurred by the supplier are considered to be "normal costs" and no penalty cost is incurred.

One of the method related to reliability indicator methods which can be used to estimate the logistic system reliability is the "Perfect order fulfilment" method (Szozda & Werbinska, 2011, p. 149) where is used indicator OTIF (On-time, In-full, Error- free) that is calculated from the formula:

 $OTIF = P_{o-t}P_{i-f}P_{e-f}$  where:  $P_{o-t}$  - probability of on-time delivery;

P<sub>i-f</sub> - probability of in-full delivery;

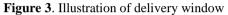
Pe-f - probability of error-free delivery.

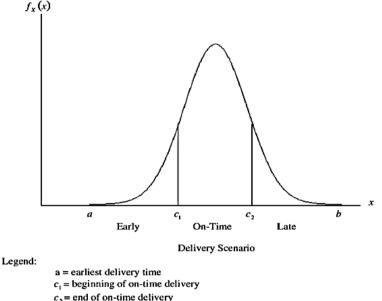
CSCMP (2013, p. 134) define OTIF as sales order delivery performance measure which can be expressed as a target, say, of achieving 98% of orders delivered in full, no part shipments, on the requested date.

# 4.1. Delivery window – framework for managing delivery performance in the outbound vehicle logistics

One of the important goals of the supply chain in the outbound vehicle logistics is how to achieve delivery performance based on the customer's specification of delivery timeliness which is defined by delivery window. Under the concept of delivery window is possible to analyse the costs caused by untimely delivery. According to Corbett (1992, p. 74) delivery windows are an effective tool for modelling the expected costs associated with untimely delivery. Johnson and Davis (1998), note that metrics based on delivery windows capture the most important aspect of the delivery process, which is reliability.

A delivery window is defined as the difference between the earliest possible delivery date and the latest acceptable delivery date. Delivery window is illustrated on figure 3; the OEM and customer contractually agree about the framework for managing delivery performance, which is between an earliest allowable delivery date (a) and a latest allowable delivery date (b). Within the delivery window, delivery can be early, on-time, or late. According to Guiffrida and Jaber (2008), delivery lead time, X is random variable with probability density function fX(x). The on-time portion of the delivery window is defined by  $c2_c1$ .





b = latest acceptable delivery time

Source: Guiffrida A.L., Yaber M.Y., 2008, p. 2151

According to Shang & Liu (2011, p. 601) late deliveries frequently exist in many different industries and lead to a deteriorated delivery reliability to customers and will have a long-term negative effect on customers demand.

Usually in outbound vehicle logistics pick up time in which logistics company is obliged to collect the vehicles from the factory is between 24 and 72 hours from the day of the transport order. Transport time to the dealership depends on the distance from production plant to final destination. In case of late delivery in a outbound supply chain logistic service providers should be penalised with penalty costs that are incurred in addition to the normal operating costs. In case that a delivery is performed within the on-time portion of the delivery window, there will be no penalty cost. In 2016 were produced 72 million cars produces worldwide. According to ACEA (2017), the volume of vehicles (first three brands) sold by selected luxury car brands in 2016 is: Mercedes-Benz 2,08 million units, BMW 2,00 million units and Audi 1,87 million units. The three German premium brands have increased their combined share of the European market to 17% from 10% two decades ago (Hetzner & Cifferi, 2015).

Mercedes-Benz connected in their outbound logistics approach, the degree of delivery date fulfilment with their performance related payment system for providers in which they motivate their partners with a bonus to exceed the agreed targets (Ludwig, 2013). Based on this concept of "self-adjusting system" they continuously improve promised delivery dates. Measuring of delivery times is focused on vehicle pick up accuracy and compliance with contractual transit times.

BMW outbound logistics is focused on process stability, data analysis and continuous improvement. Their project "Pro-Flex" includes critical features for vehicle logistics and ability to prioritise sold vehicles and expedite them through transport and accessory-installation.

### 4.2. The concept of "Liefertreue"

The concept of "Liefertreue" is explained on the case of Audi outbound supply chain and delivery reliability. Audi is one of the world's leading premium automotive brand. It continuously tries to build high quality and technologically progressive cars with philosophy "progress through technology" (*germ. "Vorsprung durch Technik"*) which has clear goal to bring high quality to their customer first. Also, one of the important concepts related to their outbound supply chain is the concept "Liefertreue" focused on delivery reliability. Based on analysis of the differentiation for premium brands and relevance for their customers, delivery reliability and amendment flexibility are the most important factors of success in the competition of premium brands (figure 4).

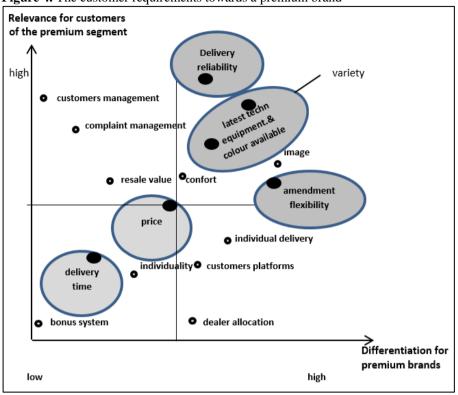


Figure 4. The customer requirements towards a premium brand

High relevance for customers of premium segment have: resale value, complaint management and customer management. Also, car prices and delivery times are not strong marks of differentiation in customer requirements towards a premium brands. In addition, for customers are very important latest technology, variety of equipment and availability of colours. Anyway, delivery reliability is most significant mark of differentiation.

Therefore, the functions of logistics are oriented on increasing of the flexibility in the order-to-delivery process which include monitoring of the release dates, sales planning and capacity planning. Buyers expect information about the estimated time of arrival (ETA) of the vehicle at dealers when vehicle orders are submitted. ETA actually turns order-to-delivery process and influence on the inbound and outbound supply chain. Audi measures mentioned process of delivery reliability (Liefertreue) which is on the 97% and customer orientated. Of course, target is always 100%.

For improvement of ETA accuracy is very important to have clear picture of the chain and not see the real customer as the next customer in the chain for eg. production is customer of logistics, because the real customer is only one that paying for car and therefore should be in focus (Ludwig, 2014, p. 1). High delivery reliability positively

Source: Krog, 2016, p. 13

influences on the customer satisfaction, reduction of lead time and reduction of the logistics cost.

### **5. CONCLUSION**

Automotive supply chain (outbound vehicle distribution) is very complex activity because it is tied to the automotive industry which produce vehicles - the most complex products on our planet. From other side, process in finished vehicle logistics involves a large number of entities due to fact that vehicles constantly changing hands at various places and transportation modes what is very challenging for OEM's. Therefore, they outsource logistics and transport activities to specialised intermediaries, logistics service providers (third-party logistics service provider, fourth-party logistics service provider or lead logistics provider) which optimise supply chain performance, provide improving solutions and value added logistics service. Based on the scope of needed logistics service every automobile manufacturers decide which type of logistics provider is most suitable for their outbound supply chain. Also, finished vehicle logistics can be seen as a key competitive factor in the automotive industry due to the rising number of model variants and option in supply chain where is essential, continuously to pay attention on the evaluation of logistics effectiveness and efficiency.

The best tolls for improving and optimising outbound supply chain performance are key performance indicators which are used often in a post ante context, to evaluate a past performance of logistic service providers. The most important key performance indicators in vehicle distribution are: on time pickup, delivery reliability, transit time, lead time and damage-free delivery.

Delivery reliability is a crucial factor of successful finished vehicle logistics provided by logistics service providers. Indication of the delivery performance is the most important metric in outbound supply chain management that integrate the measurement of performance from car production plant to the dealers. Premium automotive brand is focused in their outbound distribution to create the most efficient concept of their supply chain which in maximally focused on the customer satisfaction, reduction of lead time and reduction of logistics costs. In top performing outbound supply chains of premium brands, delivery time met 97% to 100% of on time delivered vehicles. Therefore, continuously measurement of on-time delivery has a fundamental importance for quality evaluation of performed logistics service.

Considering analysis of delivery reliability in outbound vehicle distribution, future research should be directed to developing more detailed method, models and tolls which can improve design of whole supply chain.

Finally, it is important to emphasize the fact that outsourcing trend in automobile industry will increase relevance of finished vehicle logistics as a source of competitive advantages for OEM's on the way of achieving high customer satisfaction.

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## COMPETITIVE ADVANTAGE IN COST SENSITIVE GLASS PACKAGING INDUSTRY THROUGH OUTBOUND LOGISTICS

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### Abstract

Achieving and maintaining a long-term competitiveness is one of the key prerequisites of a sustainable business. Companies put a lot of effort into enhancing different value chain activities in order to achieve it. Initially, manufacturing companies were focused inwardly on increasing efficiency of tightly controlled logistics activities. When those opportunities were exhausted, the focus expanded beyond the firm boundaries through establishing trust-based relationships with specialized logistics service provider (LSP) companies. The aim of this paper is to analyse a case of innovative outbound logistics practice within mature glass packaging industry. Due to relatively high weight and low utilisation of freight space, glass packaging is considered as unsuitable for long-distance transportation. With incrementally small developments in improvement of freight space utilisation, high transportation cost remains as one of the most restrictive industry level success factors. Based on a series of in-depth interviews with management personnel of a European mid-sized glass packaging producer, innovative approaches in its outbound logistics practices has been evaluated. Paper analyses the process of close cooperation between the manufacturer, customer and LSP which resulted in an innovative solution and optimisation improvements within the outbound logistics activities. As the findings suggest, close cooperation between stakeholders and customer co-creation contribute to the company's competitive advantage.

Keywords: outbound 3PL, customer value, value co-creation, glass packaging industry

### **1. INTRODUCTION**

Traditionally, manufacturing companies were primarily devoted to optimizing inbound logistics and cost cutting within the supply chain as a primary path to superior

performance. However, with on-going development of a trust-based long-term relationships with customers, (re)focusing on the outbound logistics and development of innovative solutions together with logistics service providers (LSP) is gradually emerging as the new area through which companies seek to enhance market performance. A review of the literature reveals that third-party logistics and logistics outsourcing have meant different things to different people since the subjects first appeared in the academic literature in the late 1980s (Leuschner et al. 2014). The thirdparty logistics (3PL) is commonly referred as the outsourcing or contracting-out of multiple or all components of logistics that were previously organized in-house (Prockl et al., 2012). As the result of this development, third-party logistics service providers (3PLSPs) emerged. Giri and Sarker (2017) define a third-party logistics service provider as an independent enterprise who does not own the product(s) or service(s) but participates in the supply chain and provides logistics services under a contract to the manufacturer, retailer(s) and/or consumers of a product or service. The third party logistics and its alliance with the clients, therefore, play an important role in modern supply chain management. This way businesses are outsourcing part or all of their supply chain operations, and are able to reduce the burden of logistics activities in order to effectively reduce logistics cost and enhance customer satisfaction and overall performance. Maloni and Carter (2006) pointed out that three primary reasons for outsourcing logistics services are (1) service improvements, (2) cost reduction, and (3) a desire by the organizations that purchase these logistics services to focus on their own, non-logistics core competencies.

Outsourcing logistic processes became a general trend for the movement and storage of goods and information within companies' supply chains (Núñez-Carballosa & Guitart-Tarrés, 2011). The most recent annual studies found that over 54% of shippers' transportation spend and 39% of their warehouse operations spend were outsourced (Langley, 2012). Additionally, the use of a 3PL provider to take over some or all of a firm's logistics responsibilities is becoming more prevalent, and more than 70 % of companies in Western Europe, USA and Asia Pacific have logistics outsourcing experience (Hsiao et al. 2010). On the other side, Jiang et al. (2016) study found out that whether the cost sharing contracts perform well critically depends on chain members' unit profits. Only if chain members have sufficient profit margins to compensate the logistics cost of the 3PL provider, then the cost sharing becomes an effective strategy, and the cost sharing mechanisms enable the chain members' profits to increase.

In the US and Europe, 3PL has shown its great potential; it is now close to its maturity stage of life cycle. In Asian countries like China, Japan and India, 3PL is in the path of high growth stage. However, there has been a further evolution in supply chain outsourcing and it is called Fourth-party Logistics or 4PL because corporations are now looking for chain integrator, a single outsourcing partner who will assess, design, build, run and measure integrated comprehensive supply chain solutions on their behalf in a sustainable way (Mehmann & Teuteberg, 2016). For example HAVI Logistics has set up an extensive logistics network for McDonald's across Europe in order to be able to supply about 5,300 restaurants with quality food and packaging every day. 4PL is the new type of outsourcing in logistics services, of which the

appearance is not only on the basis of the development of IT, but also the application of the Theories about the Modern Division and Exchange Cost (Qiuping, 2011).

The aim of this paper is to analyze a case of innovative outbound logistics practice within mature and partially rigid glass packaging industry. Paper analyses the process of close cooperation between the manufacturer, customer and LSP which resulted in an innovative solution and optimisation improvements within the outbound logistics activities.

# 2. VALUE CREATION THROUGH OUTBOUND THIRD PARTY LOGISTICS

Long-term relationship characteristics between partner companies are continuously evolving from the aspect of lower or higher operational integration. The growing number of strategic alliances that companies are entering serves as a vivid reminder of numerous benefits that companies perceive materialising by engaging in deeper operational relatedness with their partners throughout the supply chain. However, as complexities rise, it becomes costly for companies to manage rising number of complex activities between them, hence the specialist companies enter into the relationship. One of the most common activities that these types of companies undertake within the supply chain are logistic activities.

Hertz & Alfredsson (2003) point to the fact that successful management of complex interfirm relationships up to the level of co-specialization serves as a prerequisite for co-utilization of resources and customer value creation in today's logistics activities. However, most of the studies focus mainly on studying logistics providers on standalone basis rather that as in intermediary in the context of their relationship (strategic and operational ones) with both supplier and buyer of products they carry.

The development path of logistics providers signals that closer integration with supply chain parties is increasingly the only pathway for successful long-term value creation by logistics partners (Wang et al., 2016; Hammervoll, 2014). Modern logistics providers have evolved through different phases of development to reach today's level of operations. Starting as mostly transport companies, they have expanded gradually through time the scope of services they offer to cater better to the growing logistics needs of industrial companies. As the scope of their activities grew, they have gradually transformed themselves into integral transport providers offering full scope of logistics services that industrial companies have previously undertook on their own and have now outsourced (Berglund et al., 1999). Next to growing in scope, advancing the quality of services offered also became a pressing issue for logistics providers. Often times, lacking the needed know how in a specific area, logistics providers have used specialized companies for specific tasks with the supply chain which marked the emergence of both 3PL and 4PL (Forth Party Logistics providers) companies.

Increased complexity of supply chains due to growing pressures for cost effectiveness and longer distances between the source and final destination of the goods, necessitated the need for closer cooperation (strategic level) and closer integration (operations level) between the logistics provider and buyer and seller of goods in order to maximize value creation. Hertz & Alfredsson (2003) have specifically analysed logistics service providers with respect to two key dimensions: general problem solving capabilities and customer adaptation. Based on those two dimensions they differentiate logistics providers as: service developers, customer developers, standard 3PL providers and customer adapters. Last one being potentially most beneficial to supply chain parties but also most difficult to achieve considering the growing complexities within the supply chain.

Research points to numerous benefits of customized customer adapting approach in delivering logistics services. Tate (1996) pointed out many of the benefits of collaborating or establishing partner-like relationship with logistics companies. However, for those relationships to yield benefits they must be founded on a set of important pillars such as deeply understanding partner's needs, open communication and fairness and above all commitment and trust. Bowersox (1990) has listed similar benefits like previous researchers and has early on pointed to the need of constant management of partner relationship in order for the benefits to clearly materialize. Above other issues, he signalled out cultural factors as increasingly important for predicting success of the alliance. Management and advancement of alliance cooperation and alliance itself was recognized as another important goal that partners must devote resource to which means they must continually focus on two distinct goals within the relationship. One is to focus on partners' value creation and the other is to focus on developing partnership relationship with alliance partners. The complexity arises due to the fact that different set of resources and capabilities underpin successful delivery on each of the two goals.

Halldórsson and Skjøtt-Larsen (2004) focused their research exactly on the area of joint logistics solution generation between partners in the value chain and the competencies that need to be developed to achieve that goal. The essence of building the competencies for joint logistics solution generation and deployment is to manage relationship with a clear focus on development of learning processes as one of the key benefits of the customized deep-level alliance partner relationship. Development of specific expertise serves as a long-term base for value creation and the process of development of that knowledge will ideally contribute to building those much needed soft skills for managing partner relationships that will serve as a base for alliance management in the future (Sharma & Ghosh Choudhury, 2014).

Two important issues to recognize by analysing these foundation pillars of successful relationships are that they are relatively soft in nature. In other words, there is a need for the existence of types of skills that are more of inter-organizational and interpersonal in nature rather than technical. Additionally, for those type of pillars to develop it usually requires a long time through which partners assess the others side seriousness and trustworthiness in their approach.

Beyond the benefits resulting from the improvement in the dyadic relationship between the logistics provider and the industrial producer, research has identified that these benefits spill-over through the supply chain which make the entire supply chain more competitive. In the era of specialization and customization within the supply chain and between the supply chain partners, this means that external benefits accrue to other members of the supply chain as well. Using survey methodology, Kopaczak (1997) discovered the potential for greater value creation by partners engaging in mutually dependent "restructuring" (in other words "customization") of their operations which results in streamlining activities across the entire supply chain. The biggest benefits identified by the study have been in reducing the logistics related costs and in improving the order cycle costs.

Bhatnagar and Viswanathan (2000) building on Kopaczak (1997) research provided the evidence of the benefits as predicted by Kopaczak through case study research of two large multinational firms' operations in Asia. Panayides and So (2005) have finally, from the position of the supply chain wide effects, established the case for benefits arising from the partnering relationship between an industrial (manufacturing) firm and logistics provider. They have shown that relationship orientation of supply chain partners (industrial firms and logistics provider specifically) which is conductive to organization learning, significantly positively influences the performance not just of the two respective firms but of the entire supply chain as well.

It can be concluded that the case for multiple benefits arising from strategic partnership between supply chain partners, namely industrial companies and logistics providers exist. Prerequisite for those benefits to materialize are facilitation of deep level of cooperation between supply chain partners which resides on soft skill based resources and capabilities and results in customizable solutions to unique logistics problems. Benefits of this approach do not accrue only to partners in dyadic interaction but permeate the entire supply chain and create positive external effects for other supply chain members.

Translating the practices aforementioned in previous paragraph in concrete benefits is practically not easy due to numerous external constraints, usually not directly related to the business partners. European space despite numerous integration processes is still characterized by significant diversity on national level that serve as a barrier to development of Europe wide partner generated solutions in logistics, national culture being one of them. Carbone & Stone (2005) provide evidence for prerequisites emerging among European economies that are conductive to implementation of partner like relationship in multinational supply chains with potential to create aforementioned benefits. Logistics industry in Europe is gradually but steadily through mergers and acquisitions reaching the level of consolidation where companies establish Europe wide national presence, which eases the implementation of cross-nation Europe wide partner based logistics solutions.

### **3. RESEARCH DESIGN**

As the literature review revealed, partnership between suppliers and their clients is a complex construct significantly relying on both inbound and outbound logistics optimization. Due to each industry's specifics and various internal and external constrains, there are no universally applicable formulas for the supply chain optimization. However, even customised solutions can provide contribution to the overall body of knowledge within this area. This paper tries to provide an insight into very specific logistic solution developed within the glass industry. Therefore, a qualitative methodology and case study method were selected to yield a high level of detail (Golic & Davis, 2012). The study presented in this paper is based on the findings collected over a sustained period of time through a series of in-depth interviews with the sales and logistics managers employed by a mid-sized glass packaging producer (i.e. a supplier) in its Croatian and Austrian subsidiaries. The data collection was followed by a qualitative analysis of the interview transcripts. Due to the complexity, the research findings are elaborated in the form of a case study, which, as a research method, represents an empirical inquiry that analyses a phenomenon within its own environment (Yin, 2009).

### 4. THE CASE STUDY

### 4.1. Background: An Overview of European Glass Packaging Industry

For centuries, glass has been considered as a traditional packaging material. However, the production of glass containers remained manual until 1903 when Michael J. Owen presented the first automatic bottle-making machine, which represented a significant advance in glass manufacturing (Doyle, 1979; Yam, 2010). From the early 1900s until the late 1960s glass packaging dominated the market for liquid products (Berger, 2005). Since then, due to its disadvantages like weight and fragility, glass has been replaced in many applications by more modern packaging materials (Rexam Group Marketing, 2008). Today, glass packaging accounts for 10.5% of the European containers and packaging market value (Marketline, 2014).

Container glass manufacturing is an energy-intensive industry, using natural gas and electricity as main energy sources (Today in Energy, 2013). Taking into consideration an increasing trend of energy cost, glass packaging industry's cost structure is under high pressure. Another restraining factor for the industry is the bulkiness of both raw materials and finished products. Consequently, glass packaging industry in Europe formed clusters in locations that have deposits of raw materials (i.e. sand and alkaline), were near forests that used to provide firewood for furnaces, and were not far away from their clients (ECORYS, 2008).

Since the glass industry mainly supplies food and beverage industry, the demand for glass packaging is severely influenced by the overall economy, threat of substitutes (i.e. other packaging materials) and consumption trends (Alfirevic et al., 2013). The production of glass packaging in Europe dropped by around 10% between 2008 and 2014 as a result of the global crisis and demand decrease (Wintour, 2015). Consequently, the industry became even more competitive. According to some forecasts (Lucintel, 2013), glass packaging industry faces challenges due to availability of different substitutes (e.g. carton, plastic, and metal). Furthermore, volatility in feedstock prices, energy inputs, and transportation are also expected to be major challenges for the industry in future.

### 4.2. An Overview of the Company

The subject of this study is a mid-sized glass packaging producer with eight production plants within Europe. With over three thousand employees, the company sold almost 4.9 billion units of glass bottles and jars in 2016. Due to its strong customer orientation, the company strives to offer innovative packaging solutions and high-quality products, together with on-time deliveries. The company has a strong and well developed customer care comprising services prior delivery, services related to delivery and after sales services, together with the technical support focused on product development. To retain valuable customers, the company's priority it to develop and maintain long-term relationships and business partnering through multilevel communication (i.e. direct and indirect communication between various company and customer's departments).

The company's customer base comprises international key clients, key clients limited to a single country or a region, medium-sized clients and small or occasional clients. In order to maintain sustainable operation, the company developed different relationship strategies for different categories of customers. Obviously, more emphasis is put on key clients, since in some subsidiaries they account for up to 80% of the total revenue. In overall, the importance of key clients within the company's revenue structure increased in past decade due to mergers and acquisitions within food and beverage industry that took place across Europe. With this development, loyal customers increased their annual orders and, consequently, increased interdependency with their glass packaging supplier. However, due to excess supply and high level of competitiveness within the industry, there is a high pressure on prices and commercial terms. To maintain its competitiveness, the company has to improve the control of cost structure and improve processes that could potentially lower cost or provide more value for the customers.

### 4.3. Outbound logistics optimization

Due to its weight and bulkiness, glass packaging is not suitable for a longdistance transportation. As a traditional industry constrain, this is the main reason why glass packaging industry is mostly a locally-oriented industry. According to a rule of thumb, transporting glass packaging by trucks on distances over 500-600 kilometres significantly reduces cost-effectiveness. In other words, company's competitiveness sharply declines with longer distribution routes due to high freight cost. The company manages its profitability by delivering roughly 80% of its products to the customers within this distance, while the remaining deliveries are directed to more distant and, consequently, less profitable customers. Although railway, due to lower cost, increases the transportation distance constrain, its biggest disadvantage is that it cannot qualify for the just-in-time deliveries.

In order to improve outbound logistics process, the company analysed the whole process and detected some improvement potential. Firstly, the company developed an optimum transportation packaging solution. While the company offers a number of various transportation packaging options to suit customers' needs and wants (e.g. different pallet types, variable pallet size, five interlayer options), it could result with low load utilisation of a truck. Therefore, the company proposed an optimum transportation packaging based on DIN pallet (1200 x 1000 mm), plastic (reusable) interlayers and height around 2.3-2.4 meters, together with an optimised palletisation plan that minimises empty space within a pallet. According to calculations, transportation packaging optimization could result with 5-10% better load utilisation and decrease of freight cost per unit.

However, the packaging optimization project was not completely successful due to some real-life limitations. First, some trucks were not capable of carrying pallets with height over 2.2 meters. However, this was easily solved the specification change for the transportation companies. More challenging were the customer related limitations. For the majority of customers a shift from EUR to DIN pallet was simply impossible due to limitations of the installed de-palletisation equipment. Same limitations also affected the intention to increase the overall pallet height. The proposed solution in this case was the switch to lower pallets. This way, a single pallet space can contain two pallets of goods, one loaded on top of the other. This has negative impact on the loading and unloading time because it requires more time, but it can improve the load utilisation.

An improvement with higher acceptance rate among customers was the switch from one-way carton interlayers to plastic reusable interlayers. While plastic interlayers are mandatory when packaging is being pushed to the discharge table during the de-palletisation, they proved to be functional also in case of gripping and manual de-palletisation. For the full utilisation of returnable interlayers, the company also improved the reverse logistics processes (i.e. plastic layer collection and cleaning).

While transportation by road is an industry standard and mandatory requirement for the just-in-time deliveries, the company also tried to re-introduce transportation by railway, especially where there was not just-in-time delivery requirement. While some customers embraced the alternative, the majority of customers did not accept this potentially cheaper mean of transportation with lower carbon footprint. In most cases, the main reason was the lack of infrastructure and cost related to additional loading and unloading of pallets before reaching the final destination.

# 4.4. Long-Distance Transportation Exercise (or moving outside the comfort zone)

While maintaining economic sustainability, the company also delivers to customers at greater distances. With the transportation cost escalation, long routes has negative impact on performing just-on-time deliveries. However, when it comes to international key customers, the company has a strategic goal to improve cooperation and increase annual deliveries. Sometimes, the only way is to start delivering to some very distant location.

Few years ago, one of the top clients requested deliveries to their UK plant. With the distance well over 1000 kilometres, the company has to provide just-on-time delivery, while the overall sourcing cost has to be at the level of local supplier, or just slightly higher. Without doubt, this was really a great challenge for the company.

Prior the delivery, the company discussed all the requirements with the customer, especially the just-in-time delivery requirement. Since it was almost impossible to deliver at specific time, taking into consideration both the distance and road conditions, the requirement for a logistics partner (LSP) or a 3PL provider was obvious. The client also shared some of its previous experiences with the supplier from Saudi Arabia that also utilised services of a logistics partner. In their case, the bottles were transported by sea and stocked in a local warehouse until the client requested delivery to its filling plant.

After few weeks of searching, the company managed to find a logistic partner owning a warehouse near the clients filling plant. The LSP offered warehousing and visual inspection of shipments, which is an important service in case of long-distance glass packaging transportation. Due to material specifics, long-distance transportation causes high stress for glass containers, so there is a certain risk of breakage. By visual inspection of the pallets, the LSP ensures that, after a long-distance transportation, the client will only receive defect-free products.

The company offered two transportation options – by railway and by road. Since the logistic partner's warehouse had no direct railway link, the railway option also includes short transportation route by truck, why this option was between 3% and 5% more expensive, depending on the container size. However, the client choose the railway option due to its lower overall carbon emission.

### 5. CONCLUSION

Although this research study has some obvious limitations due to being focused on just one company and very specific industry, there are certain findings that may provide benefits for both academic researchers and professionals. While in case of the former, this study provides a good starting point for further research of logistic aspects of developing competitiveness within the packaging industry; in case of the latter, this study may sparkle creativity in the supply chain optimization process. Although solutions presented in the case study are being present for a long time within various industries, their application within very traditional and rigid industry is relatively new and represents certain improvement over the long-lasting industry standards.

The case study revealed some good practices of a mid-sized European glass packaging producer. In order to improve its competitiveness, the company conducted a series of activities in cooperation with both the client and the logistics service provider. This resulted with the development of two levels of partnership within the supply chain. The most important is obviously the long-lasting partnership between the supplier and its client. The second partnership is the one developed between the supplier and the LSP, which actually enhances the partnership within the supplier and its client by providing value for both sides. The supplier improved its competiveness by optimising transportation packaging and eliminating certain constrains related to the long-distance shipping of glass containers, such as not being able to offer just-ontime delivery. On the other hand, the client successfully minimised the risk of relying solely on the local suppliers and extended the level of cooperation with its supplier. This study contributes the growing body of literature focused on European logistics and industry practices by establishing a case of emerging benefits arising through developing and nurturing partnering relationship between a supplier and its logistics partner through generating customized solutions whose impact is noticeable across the entire supply chain. The findings and implications of this research are even more important due to the fact the industrial company analysed is positioned in the mature industry and this research could point to new cooperative strategies available in mature industries that could change the stale industry dynamics of those industries.

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## MAPPING OF NATURAL GAS SUPPLY CHAINS: LITERATURE REVIEW

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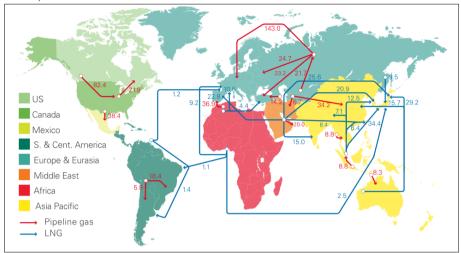
### Abstract

Natural gas is third most important fuel in the world with extremely complex supply chain that effects around one third of natural gas price. To mitigate complexity, to clarify position and processes, and to ensure maximum possible optimization of natural gas supply chain, practitioners and scientist use mapping method in creating a "picture" of natural gas supply chain. Aim of this research is to provide guidelines for effective use of mapping method in natural gas supply chain researches. Indicative preliminary research has be done by analysis analyzing and comparing most relevant scientific papers dealing with natural gas supply chain and their use of natural gas supply chain maps. Articles were analyzed according to following criteria: use of supply chain maps, type of used supply chain maps and selected supply chain map's attributes: coverage of map, spatial character of maps, number of supply chain tiers presented in maps, is there a focal point in maps and do maps highlight cycle view of supply chains. Results indicate that supply chain maps are essential tool for natural gas supply chain mapping where researcher mostly choose relationship based maps of evenly whole or part of supply chain, most often with 5 supply chain tiers, with no explicit spatial aspect, and no focal point and cycle view. Main study limitations are use of only one (although biggest) databases and limited number of papers taken into consideration. In further researches other relevant databases should be taken into consideration, and more specific maps' types could be analyzed.

Key words: supply chain, supply chain maps, natural gas, mapping

## 1. INTRODUCTION

Natural gas is fossil fuel that is third most important fuel today after coal and oil (Statista, 2017), and the fastest growing component of world primary energy consumption (Demirbas, 2006). It is also more environmentally friendly fuel than coal and oil (Liang et al, 2012). Specific of natural gas lies in a fact that areas of consumption and areas of production have significantly different spatial distribution, respectively some countries have significant gas surpluses, and other countries needs to import gas. Figure 1 shows natural gas trade movements worldwide.



**Figure 1.** Natural gas trade movements 2016 - trade flows worldwide (billion cubic metres)



Trade agreements are almost always followed by supply chains for delivering subject of trade – physical flows of natural gas. Flows through natural gas supply chain are using either pipelines or LNG (Liquefied Natural Gas) transport form of transportation and warehousing. There are numerous definitions of supply chain, but for this paper we cite Chopra & Meindl (2016): supply chain consist of all parties involved directly or indirectly, in fulfilling a customer request...includes all functions involved in receiving and filling a customer request. Supply chain of natural gas is complex and important part of natural gas sector. Just transmission and distribution of natural gas to final consumers, accounts for more than 30 percent of natural gas price (Hamedi et al, 2009). Huge distances, many supply chain members, different technological, logistical and economical processes, complex law and professional regulations in different countries on the way to final consumer contribute to complexity and potential risks in natural gas supply chains. To mitigate complexity, to clarify position and processes, and to ensure maximum possible optimization of natural gas supply chain, practitioners and scientist use mapping method in creating a "picture" of natural gas supply chain.

Mapping is pervasive and supportive activity that is recommended for use in all areas of supply chain management and to all members of the supply chain. Gardner & Cooper (2003) state numerous reasons for use of maps (especially strategic supply chain maps) in supply chain management, and some of most important are arising from an ability of supply chain map to increase the understanding of a supply chain (both during its developing and its dissemination), to link the corporate and supply chain strategy, to display current channel dynamics and offer possibilities for chain redesign, and to ease integration processes in supply chain – both their implementation

as well as their controlling. Even most simple supply chain map, collaboratively developed, will lead to clearer understanding of each member's position and processes in supply chain which in turn can result in avoiding of work duplication in supply chain, higher motivation, better coordination, forecasting and replenishment efficacy, and increased chances for other supply chain process improvement. This visual representation becomes a starting point (Lambert et al, 2014) for potential improvements in supply chain. Therefore, mapping (in line with use of metrics, ICT and different lean methods) has become essential tool for most supply chain practitioners and method of mapping has been widely used in scientific papers as well.

The aim of this paper is to give answer to following research questions: How often is method of mapping used in papers dealing with natural gas supply chains? Which type of supply chain maps are used in papers dealing with natural gas supply chains and what are maps' main attributes characteristics? By answering research question, paper will try to deliver its purpose – to provide overview and guidelines for more effective use of mapping method in natural gas supply chain researches. Paper starts with previous research review of supply chain mapping and continues with methodology clarification. Results of preliminary research are presented in next chapter, following by discussion and conclusion.

## 2. SUPPLY CHAIN MAPPING

Gardner & Cooper (2003) define supply chain map as a *representation of the linkages and members of supply chain along with some information about the overall nature of the entire map.* Miyake et al (2010) highlights how supply chain map result from the collection of different kinds of data and results in a holistic view that "no one person has ever caught in its entirety". There are two essential elements that every supply chain map has to indicate: supply chain entity (member) and supply chain flow. Additionally, every map describes different features of entities, supply echelons, flow directions and flow characteristics, and characteristics of other activities in this supply chain. Supply chain maps can be developed either for whole supply chain, or just for its smaller parts (relationships between two or more entities).

Different approaches to supply chain mapping exist, resulting into different supply chain mapping classifications. According to Lambert's approach to the supply chain management based on the management of relations and cooperation, maps can be divided into relationship–based maps and activity-based maps (Lambert et al, 2014). Relationships-based maps are starting point for identifying the key members of the supply chain and are used for the allocation of resources within the network organization. They are usually drawn from the perspective of a company that is in focus (focal company), and usually map is done for the needs of this company (Lambert et al, 2014). Relationship-based maps are used to create broad picture with flows and other relationships among major groups of supply chain members, and they don't focus on specific activities. Relationships and/or flows are usually represented with different types of arrows (Handfield & Nichols, 2002), and most represented are material and information flows – as an example see supply chain map in (Kolinski & Sliwczynski, 2015).

On the basis of relationship-based maps, it is more easily to found possibilities for using activity-based map approach. Activity-based maps are used for more detailed analysis of processes that occur within a single economic entity, or among the business supply chain and are mostly occurring as a part of material, information or money flow. Lambert et al. (2014) especially highlight these types of activity-based maps: time-based process maps, pipeline inventory process maps and extended value stream maps. Time-based process maps represent events and activities in certain time frame with a goal of finding possibilities for decreasing (compressing) required time for fulfilling those activities. Pipeline inventory process maps present lead times and inventory at different stages of supply chain in one map, ensuring starting point for decreasing lead times in supply chain, and consequently lowering of safety inventory. While value stream maps are used for analyzing of production processes for identifying and elimination of no-value adding activities, extended value stream maps are crossing boundaries of enterprise to other entities on other levels of supply chain. They usually include information about value creation time, first time quality, waiting time, lead-time, and transport time for each part of analyzed process. Variation of extended value stream maps are called value chain maps and they are aligning sectors and participants through shared image of "as is" supply chain processes and how they could be improved – even more success is done if they are developed collaboratively between supply chain partners (Economic Development Board, 2015).

Hill (2009) talks about classification of map used to understand and improve processes into three categories: relationship mapping tools, time mapping tools and causal mapping tools (Figure 2).

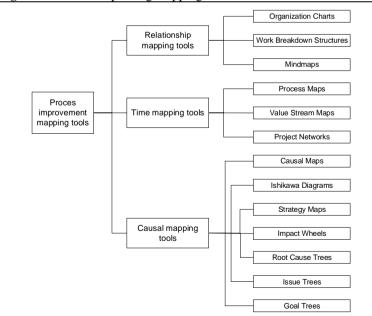


Figure 2. Process improving mapping tools

Source: Hill (2009).

As processes are in the core of any supply chain, they can be evenly used for supply chain mapping. Compared to Lambert et al (2014), Hill introduces additional group of maps that are of huge significance for supply chain – causal maps. Causal mapping tools are diagrams that are mostly used for identifying the root causes of a problem (Hill, 2012) by presenting cause end effect relationship.

As additional supply chain mapping approaches, Miyake (2010) mentions Finne's dynamic clockspeed analysis, Towill's et al. quick scan methodology, and unavoidable SCOR (Supply Chain Operations Reference) model.

Although all of these maps could be used for supply chain mapping, Gardner & Cooper (2003) differentiate between main characteristics of strategic supply chain mapping and process mapping according to its orientation, details level and main purpose. Based on their findings Barosso et al (2011) has elaborated it in Table 1.

	Supply Chain Mapping	Process Mapping
Orientation	• Focuses on how material, information, and money flow: i) in both the upstream and downstream directions, and ii) through an organisation.	<ul> <li>Can be defined as the focus of the mapping procedure.</li> <li>Generally directs its attention to a single operation or system within an organisation.</li> </ul>
Det ail	• Emphasizes high-level measures such as volume, cost, or lead time.	• Tends to break down a process into activities and steps.
Purpose	<ul> <li>Is strategic.</li> <li>Is used i) to help create a supply chain that conforms to a strategy, or ii) as a check to make sure the current chain is set up properly to fulfil that strategy.</li> </ul>	<ul> <li>Is typically tactical.</li> <li>The origin of that map comes from the recognition of a problem area and an attempt to improve operating efficiency. The goal is to make changes to the current operations of the organisation.</li> </ul>

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<b>I anie I</b> Difference between slipply ch	in and process mapping approaches
Table 1. Difference between supply ch	in and process mapping approaches

Source: Barosso et al (2011); Gardner & Cooper (2003)

In last few decades, supply chain mapping is becoming more and more used tool for predicting and in advance avoiding of supply chain disturbances that can cause different material, information or finance flow disruptions (Barosso et al, 2011, Carvalho et al., 2012, Norman & Jansson, 2004, Handfield & McCormack, 2007, Sheffi & Rice, 2005, Nishat Faisal et al., 2006). Barosso et al. (2011) are suggesting mapping approach for increasing supply chain resilience to a disturbance. Through six phases they start from current state of supply chain, and test different mitigation policies under disturbed conditions, providing methodology for making decisions about most appropriate mitigation activity.

According to Gardner and Cooper (2003), supply chain can be considered through three groups of supply chain map attributes: geometry, perspective and implementation issues. Geometry encompasses number and directions of supply chain tiers (representing supply chain length), aggregation (representing width of supply chain or competition in a tier), and spatial aspect – is a map geographically explicit representative or they are extremely simplified in spatial aspect. Perspective group of

map attributes considers focal point approach (company or industry centric analysis approach), and scope level regarding product breadth, supply chain perspective, process view depth or cycle view. Implementation issues attributes are information density, live link to database and delivery mode.

### 3. METHODOLOGY

For the purpose of preliminary literature review analysis of using supply chain maps in articles dealing with natural gas supply chain, a basic search of Web of Science Core Collection (WoS CC) database was conducted. WoS CC was chosen as it is one of most relevant and worldwide used scientific databases of academic publications. Keywords used for searching were: "natural gas" and "supply chain". They were searched within the topic of publications indexed in Science Citation Index Expanded (SCI-Expanded), Social Science Citation Index (SCI), Conference Proceedings Citation Index (CPCI) and Emerging Sources Citation Index (ESCI). The oldest paper was published in 1993, but as 95 % of papers were published from 2006, the time span used for analysis was from 2006 to 2017 (Figure 3). According to above criteria, search resulted in 347 papers (286 articles and 69 proceedings papers).

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Figure 3. Search of papers in WoS CC database used for analysis

Source: author's search in Web of Science Core Collection database (2017)

Natural gas supply chain as a topic was partly or fully covered in many research areas, and in Table 2 are presented research areas (according to Web of science categories) with 10 or more papers that met set criteria.

Web of science categories	Number of papers within search results	% of 347		
Energy fuels	138	40%		
Environmental sciences	94	27%		
Engineering chemical	92	27%		
Green sustainable science technology	47	14%		
Engineering environmental	43	12%		
Environmental studies	39	11%		
Operations research management science	27	8%		
Thermodynamics	19	5%		
Chemistry multidisciplinary	15	4%		
Biotechnology applied microbiology	14	4%		
Computer science interdisciplinary applications	13	4%		
Engineering industrial	12	3%		
Engineering electrical electronic	12	3%		
Economics	12	3%		
Transportation science technology	11	3%		
Engineering mechanical	11	3%		
Management	10	3%		
Transportation	10	3%		

Table 2. Frequency of papers across research areas

Source: author's search in WoS Core Collection database (2017)

50 most relevant papers according to WOS CC list were chosen for preliminary analysis with intention of giving an overview of supply chain maps used in articles concerning natural gas supply chain.

## 4. RESEARCH RESULTS

After initial reviewing the title, abstracts and keywords of all found articles, 6 articles (Johnson & Covington, 2014; Hui & Xiao-Ping, 2009; Kamarudin et al., 2008; Camporeale et al, 2011; De Laporte et al, 2016; Lasher et al., 2008) that are not related to any aspect of natural gas supply chain were eliminated. There were 44 articles remaining that met the criteria set. Articles were analyzed according to following criteria: use of supply chain maps, type of used supply chain maps (according to classification by Hill, 2009 and Gardner and Cooper, 2003) and selected supply chain map's attributes (according to Gardner and Cooper, 2003): coverage of map, is there spatial character in maps, number of supply chain tiers presented in maps, is there a focal point in maps and do maps highlight cycle view of supply chains (Table 3).

## Mapping of natural gas supply chains: literature review

Davor Dujak

	Article		nap	Type of SC map			Coverage of a map		Spatial		Number	Focal point		Cycle view	
			No	Relation- ship based (strategic)	Time based (proces s)	Causal maps	Whole SC	Part of SC	Yes	No	of SC tiers	Yes	No	Yes	No
1	Yeli et al. 2006										3			$\checkmark$	
2	Schulz et al., 2005						$\checkmark$				4				
3	Barton & Selot, 2007														
4	Hart & Hörmandinger, 2008			$\checkmark$						$\checkmark$	3				$\checkmark$
5	Grønhaug & Christiansen, 2009			$\checkmark$			$\checkmark$	$\checkmark$		$\checkmark$	5	$\checkmark$			$\checkmark$
6	Bittante et al., 2015			$\checkmark$							2				
	Kim et al., 2016						$\checkmark$				3		$\checkmark$	$\checkmark$	
8	Papapostolou et al., 2014						$\checkmark$				4				
9	Chebeir et al., 2017						$\checkmark$			$\checkmark$	5				
10	De La Cruz-Soto & Gutiérrez- Alcaraz, 2010		$\checkmark$												
11	Azadeh et al, 2015						$\checkmark$				5				
12	Özelkan et al., 2008			$\checkmark$			$\checkmark$			$\checkmark$	7				$\checkmark$
13	Hamedi et al., 2009				$\checkmark$		$\checkmark$				7				
14	Jokinen et al., 2015										2		$\checkmark$		
15	Kang et al., 2016										3				
	Sanches-Pereira et al., 2015				$\checkmark$			$\checkmark$		$\checkmark$	8				
	Mahendra et al., 2014						$\checkmark$				3				
	Rosetta & Martens, 2008														
	Balcombe et al., 2016			V							9				
	Khot & dnyanu Yadav, 2017										8				
	Zavala-Araiza et al., 2015			$\checkmark$				$\checkmark$			2				$\checkmark$
	Kaufmann et al., 2009														,
	Berle et al., 2011										5				
	Azadeh et al., 2016														
25	Wlodek, 2016														

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26 Vance et al., 2014		$\checkmark$									1
27 Lechtenböhmer & Dienst, 2010			$\checkmark$			 $\checkmark$		2			
28 Bekkering et al., 2013			$\checkmark$					6		$\checkmark$	$\checkmark$
29 Salcedo & Maja, 2008	$\checkmark$		$\checkmark$					3		$\checkmark$	
30 Elia et al., 2012		$\checkmark$									
31 Lee et al., 2016	$\checkmark$			$\checkmark$	$\checkmark$			7			
32 Wang & Rutherford, 2015											
33 Littlefield et al., 2017	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$			5			
34 Mladenovska et al., 2017											
35 Kalashnikov et al., 2010											
36 Grossmann et al, 2014	$\checkmark$		$\checkmark$	$\checkmark$				3			
37 Somoza et al., 2016											
38 Khalilpour & Karimi, 2012	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	 		5			
39 Mikhailov, 2016											
40 Sakaguchi, 2010	$\checkmark$		$\checkmark$		$\checkmark$			7			
41 Elia et al., 2013			$\checkmark$					3		$\checkmark$	
42 Elia et al., 2015	$\checkmark$		$\checkmark$					2		$\checkmark$	
43 Hall, 2012											
44 Miedema et al., 2016	$\checkmark$		$\checkmark$				$\checkmark$	3			

Source: author

Research has shown that supply chain maps (at least one) are used in 30 (68 %) of selected most relevant 44 papers, while only in 14 (32 %) papers authors decided not to use supply chain map to enrich their papers. For further analysis, we took into consideration only those 30 papers containing maps that are representing natural gas supply chain. Figure 4 displays results of supply chain map types used in selected 30 papers.

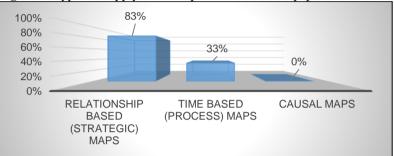


Figure 4. Types of supply chain maps used in selected papers

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Source: authors' calculation
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It can be concluded that most widely used supply chain map type for presenting natural gas supply chain is group of relationship based maps that have strategic character (in 25 papers, or 83%). Time based supply chain maps with their process orientation represent second choice for natural gas supply chain presentation (used in 10 papers, 33 %). As expected, no paper uses causal maps in natural gas supply chain presentation. In certain papers (5 of them), both relationship based and time based maps (or one map with both characteristics) can be found.

As seen on Figure 5 supply chain maps in selected papers evenly present the whole natural gas supply chain (in 16 papers), as well as only part of natural gas supply chain (in 17 papers). 2 of selected papers use maps for presenting both whole and part of natural gas supply chain.

Geographically representative maps are not common in natural gas supply chain mapping – only 17 % of papers use maps with clear spatial aspect, while 90 % of selected papers don't use maps with explicit geographic representation (Figure 6).

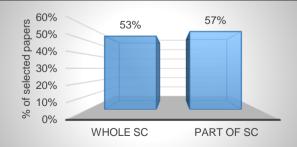


Figure 5. Coverage of natural gas supply chain maps in selected papers

Source: authors' calculation

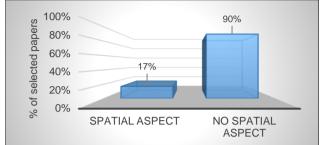


Figure 6. Spatial aspect of natural gas supply chain maps in selected papers

Source: authors' calculation

When it comes to number of natural gas supply chain tiers or echelons represented on maps in selected papers, number of tiers is very different and ranges from 2 tiers all the way to 9. For presenting whole natural gas supply chain, authors most often use 5 tiers maps, while for presenting only parts of supply chain 3 tiers maps are most often used. Additionally, time based or process maps usually have more tiers than relationship based maps.

Only 3 papers (or 10 %) use supply chain maps that are drawn from the perspective of a company or an echelon that is in focus (focal company/echelon), while 90 % of papers don't highlight one company or echelon in natural gas supply chain. And even less papers (2 or 7 %) indicate cycle view in their natural gas supply chain maps, while 28 papers (98 %) present only one way downstream flows – to the final consumer.

## 5. DISCUSSION AND CONCLUSION

The main goal of this paper was to present use of supply chain maps in scientific papers regarding natural gas supply chains. Paper intend to provide an overview of frequency of use, types and other attributes of supply chain maps used to present natural gas supply chains in existing scientific papers. Methodology of this research is based on search of WOS CC database, were 50 most relevant papers were extracted. After initial reviewing the title, abstracts and keywords 44 papers were identified as papers that deal with different aspect of natural gas supply chain. Further preliminary analysis was conducted on the basis of aforementioned criteria and attributes of supply chain maps. The results revealed that in more than two thirds of selected and analyzed papers authors decided to use natural gas supply chain maps for giving more clearer and understandable situation, relations or process flow in natural gas supply chain.

The most often used type of supply chain maps for mapping natural gas supply chain are relationship based maps (in 83 % of papers), based on strategically approach to primarily supply chain members and flows. This is very common in presenting supply chains as relationship based maps are suitable for presenting more static environment shown in general representation of all supply chain tiers (or few tiers as a part of supply chain), what is most often case in natural gas supply chain papers. Almost three time less are used time based supply chain maps that usually appear in

form of process maps. According to this study, the whole natural gas supply chain is almost equally often represented on maps in selected papers as only parts of natural gas supply chain – this results from the main topic and accents of paper's research. Geographically representative maps are rear in papers dealing with natural gas supply chain, and great majority of papers use supply chain maps with no explicit spatial aspect. This could be explained with less importance of spatial aspect for optimization or other aspects of natural gas supply chain, and with difficulties of representing huge geographical areas on which natural gas supply chains stretch. Furtherly, natural gas supply chain maps mostly don't use focal approach and cycle view (as there are almost no return flows in natural gas supply chain). As a general conclusion, supply chain maps are essential tool for natural gas supply chain mapping where researcher mostly choose relationship based maps of evenly whole or part of supply chain, most often with 5 supply chain tiers, with no explicit spatial aspect, no focal point and cycle view.

As an indicative preliminary research, this study has certain limitations like use of only one (although biggest) databases and limited number of papers taken into consideration. In further researches other relevant databases should be taken into consideration, and more specific maps' types could be analyzed. Nevertheless, paper could serve as a good starting point for researchers who would like to use mapping method in their papers dealing with natural gas supply chains.

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# V. RETAIL AND DISTRIBUTION LOGISTICS

# COMPETING MANUFACTURERS AND RETAILERS IN FOOD RETAILING: THE EFFECT CONTRACTUAL DESIGN ON SUPPLY CHAIN PERFORMANCE

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#### Abstract

The distribution of fast moving consumer goods (FMCG) via manufacturerretailer supply chains is analysed. Packaged goods in grocery channels are supplied by manufacturers to retailers selling them on to consumers. The products are standardized and branded so that each manufacturer is in competition with other manufacturers as the products within a category are to some extent perceived exchangeable by consumers. Similarly, the retailers' offerings are composed widely of the same items and brands. This competitive scenario is shaping the contractual relation between each supplier and retailer. In many instances, fierce bargaining is often the reality in the manufacturer-retailer relationship. This paper reviews the setting of the distribution of groceries in European markets. We provide empirical evidence on bargaining processes and the contractual conditions. Furthermore, the effect on supply chain performance is shown by various examples.

**Key words:** manufacturer-retailer competition, bargaining, contracting, supply chain performance

## **1. INTRODUCTION**

Retailers supply consumers with products. Especially, the supply of daily products to satisfy daily needs like foods, beverages and personal care items is a large industry. In most markets this part of retail business forms the largest portion of national retail market, i.e. in Germany about 41%. Due to large frequency of need the inventory turnover rate is large and these products are called fast moving consumer goods (FMCG).

Food retailers developed into large chains operating hundreds or even thousands of outlets. This happened very often by organic growth as well as mergers, e.g. an unprofitable retailer is overtaken by its profitable competitor. Also the German market has shown large mergers in recent years (e.g. Edeka bought large part of the Tengelmann and Plus chain). Retailers also standardized their processes and multiplied store formats into locations. Many of the chains have a uniform appearance by design of outlets, assortments offered and services supplied to consumers.

Due to growth of retailers the market concentrated to a large extent. For example, the top four retailers in Germany reach a market share of about 67% (Edeka 25.3%, Rewe 15.1, Schwarz 15.0, Aldi 12%). Other European markets show similar concentration.

In order to realize economies of scale logistics processes are standardized. Also, buying is centralized, i.e. the buying headquarter contracts with any supplier on the terms of supply.

But also the products sold by food retailers are standardized, i.e. the food industry supplies standardized items as they are aimed to serve a mass market. Each item is produced unchanged in thousands or millions of units each year and sold to manufacturer's clients, e.g. retailers. This is especially true for processed food items that are supplied in standardized packaging (consumer packaged goods/CPG).

A typical CPG item is supplied to a number of retailers. Hence, many retailers compete by offering same items. A consumer changing store may still have the chance to buy his favourite products at some other retailer. Consequently, price of item will become important for consumers' choice of store.

For the retailers this setting means that pricing of items and product lines is an important part of marketing mix. The consumer price of item – the price a retailer sells an item to consumers – determines the number of units sold. Consumer price minus the buying price – the price the manufacturer receives – forms the unit's contribution margin. So, the attractiveness of each item to the consumer and its buying price are drivers of retailer's profitability (Buzzel & Quelch 1990).

Obviously, food retailers compete on price for store patronage. Therefore, it is not surprising that retailers focus on lowering buying prices in order to sell at low prices (low shelf price of item and/or low promotional prices) and still aiming to realize a high unit margin.

Besides optimizing sales and services to improve consumer response they try to reduce costs. Cost can be reduced by streamlining processes of retail activities and reducing the cost of merchandise. Actually, the largest portion of cost of a retailer is caused by the buying price of items traded. For example, in food retailing the buying cost average 60 to 70 percent of turnover; food discounters cost reach about 80 percent of turnover. Hence, retailer's profit is leveraged by the buying prices. Retail buying is aware of its critical role and tries to reduce total cost of acquiring merchandise, i.e. buying prices, steadily. Furthermore, not only buying prices (retailer's perspective) or wholesale prices (charged by the manufacturer) and rebates thereon are of interest but also other payments, i.e. so-called side payments that the supplier pays for example in exchange for promotional efforts the retailer spends on supplier's product. Also, other terms and conditions of payment like the credit period the retailer tries to prolong in order to reach competitive advantages in buying. Hence, the supply and marketing of manufacturer's goods via the retailer is accompanied by a number of agreements. These conditions have impact on sales performance and profits of the supplier and the retailer. The buying price and its terms are in the center of this paper.

#### 2. THE MANUFACTURER-RETAILER RELATIONSHIP

#### 2.1. Supply Chain Dependency and Conflict of Interest

There is a close relationship between manufacturer and retailer as they are two consecutive members of a value chain. Retailers form the market for manufacturers, whereas consumers form the market of retailers. Any retailer sells the products sourced from suppliers to consumers. Each retailer offers to the consumer a variety of manufacturers' products to select from. Hence, retailers have difficulties to differentiate their offering from competitors. Considering a single product, a retailer can be viewed as interchangeable to any another retailer as long as both offer this item. However, the retailers' offerings differ by services (attractiveness of assortment, helpfulness of salespeople, ease of shopping, etc.). But still a large portion of the value delivered to the consumer results from the product. Also, the product causes a large portion of the cost of the retailer. Therefore, the retailer tries to reduce buying cost of products as much as possible. The bargaining on prices and terms of product supply between retailer and manufacturer became a very prominent part of their relation. Obviously, the manufacturer and retailer depend on each other. However, they are still two different firms that strive to generate profits. Though within the same supply chain there are conflicts of interest. The pricing of products delivered is at the core of this conflict.

## 2.2. Types of Buying Agreements and Pricing

There is a variety of pricing methods used in retailing of consumer goods (See Bendl, 2000, pp. 69-76; Kunter, 2009). We define a standard price of item as the price the manufacturer charges to the retailer for a unit of product supplied (See Kunter & Guhl, 2010, p. 744). Starting from this standard price a variety of discounts that reduces standard price is applied in practice. It is very common that the set of agreed discounts is applied to all the products the supplier delivers to the retailer. Besides working with a discounted standard price sometimes retailers agree directly on a price of item. In this case the retailer and the manufacturer bargain on each item's price the manufacturer supplies. Generally, the discounts or prices agreed are kept fixed for one year until they are reviewed and subject to a new round of bargaining.

The pricing of items is variable, i.e. it is only applied on delivered and invoiced units. The discounts reducing standard price of item can be viewed as payment of the manufacturer to the retailer. Hence, this part of pricing is variable as it depends on volume.

There are other parts of the tariffs bargained between manufacturer and retailer that are independent of volume delivered. For example, it is very common that the retailer promotes sales of individual products by advertising. Then, the retailer asks for a payment regarding this promotion. This payment can be interpreted as a reimbursement of cost incurred to the retailer, though the costs of advertising incurred by the retailer are not transparent to the manufacturer. Other payments are related to introducing of a new item into the assortment, known as slotting allowances. Or, payments the retailer asks for when opening a new store.

Due to the intermediate position of the retailer between manufacturer and consumer the manufacturer depends on the retailer. This is true in case of concentration in the retail market, i.e. there is less opportunity for manufacturer to reach a consumer if not by this specific retailer. It is reported by industry press that manufacturers complain about increased power of retailers as retailers have grown and retail markets became more concentrated. As a consequence, discounts and Competing manufacturers and retailers in food retailing: the effect contractual design on supply chain... Volker Trauzettel

allowances are said to be inflated and not related any more to cost or activities of the retailers. Hence, allowances and discounts are profit generating devices that serve to transfer profits from the supplier to the retailer. (See Gomez et al., 2007; Spork, 2006, Miklos-Thal et al., 2010)

#### 3. EMPIRICAL INVESTIGATION OF CONTRACTS

#### 3.1. Description of the Sample

This paper analyses a single retailer. The retailer is a large food retailer in Germany. Its market share is above 15 percent and it operates numerous stores. The stores' formats belong to supermarkets (small to large), hypermarkets and discounters. The formats operate under different brands. Main decisions regarding sales, like assortment and promotions, are taken by national headquarters.

We look at the contracts of this retailer with its suppliers. The sample consists of all the suppliers of a single category, the category of cheese. It contains all suppliers of cheese that reach a minimum yearly turnover of about one hundred thousand EUR. We counted 231 suppliers. We report about the contractual terms before year 2012 for privacy reasons. However, regarding the general setting of the contracts there are no structural changes to today, though there are differences in the size of payments and discounts agreed with suppliers.

As the suppliers considered supply within same category the contractual terms can be compared as the products supplied are competing and close substitutes. So the results are not skewed by cross-sectional effects, e.g. the market of beverages is different from the detergents' market or the market of chees. So, conclusions from the size and type of discounts cannot be drawn in such a case. Also it is a sample of one retailer. Interviews with industry managers and with retail managers revealed also that retailers have different strategies where to put emphasis on. For example, a large competing retailer puts more effort on agreeing net prices combined with less high or no discounts.

#### 3.2. Contractual Structure Observed

The suppliers supply items within the category and some of the suppliers also within other categories. If the supplier covers multiple categories contracting covers the whole supply. The retailer usually starts contracting with a supplier if this supplier reaches a certain turnover and supplies over a longer period. For example, one-shot supply agreements of a new supplier are not subject to extensive negotiations.

Analysing the contracts of the retailer with its suppliers we find a homogeneous structure. The contracts have a similar style and contain similar elements though the agreed size of rebates and payments are not identical throughout suppliers. Hence, regarding the supplier-retailer-relationship we conclude that it is the retailer who has the power in this relationship as the retailer succeeds to contract on certain elements with the suppliers in the same manner. This is contrasting the industrial organisation literature that models Stackelberg games with the manufacturer as leader and the

retailer as follower to describe the bargaining relationship. (See for reviews on the literature: Lafontaine & Slade, 1997; Kasulis et al., 1999; Corbet & Tang, 1999; Rey, 2003; Rey, 2012, Rey & Vergé, 2008, Rey & Vergé, 2016)

There are some exceptions to the homogenous appearance of contracts: If the supplier by itself offers certain terms, like rebates on volume, length of payment period or discount for paying within payment period then these offerings are likely to be taken over to the contract. It was expressed by management that these exceptional terms are likely to lead to more favourable discounts for the supplier regarding other terms.

The structure of the retailer's contracts contains the following basic elements:

- General deduction
- Due date for payment/ credit period and prompt payment discount
- Logistical discounts
- Sales-related discounts
- Service-related discounts
- Other discounts (ECR)
- Sales promotion agreements

Hence, each element reduces the payments of the retailer to the supplier. Most parts of these payments are in form of discounts on standard price (list price). Only the promotional agreements are fixed amounts (Euro values).

The largest portion of the discounts is individually agreed between supplier and retailer. The total volume of discounts reaches up to 43 percent of standard price. However, in few instances they are low at about 5 percent. Fixed payments cannot be assessed in their size as total sales were not available for this study. However, according to buyers, the total value of discounts is by far larger than the total value of fixed payments.

We observed that fixed payments are larger for large national suppliers with highly known brands. It appears that they support their brand as retailer's promotion serve to brand building purposes.

The main difference in discounts and payments results from the type of item. Private label items show low discounts. If a manufacturer supplies its national brand as well as private labels, sales of national brand products and retailer's brand item are separated and the conditions turn are set to be different. Though the conditions are different on paper they were bargained within one round together. Discounts on private label items are below 9.5 percent whereas regular discounts range above 20 percent.

Some of the conditions are the almost the same for each supplier. For example, there is a contracted discount for any supplier also having business with the retailer in foreign markets. It ranges from 1 to 2 percent whereas the total discount varies from supplier to supplier, i.e. from 0.8 to 36 percent.

The general retail discount is said to cover the service of del credere and debt collection. It varies strongly within range of 7.2 percent between suppliers.

Logistical discounts serve to compensate for the service that a supplier does not have to deliver directly to stores. They are about 5 percent.

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Sales and service related discount serve to refund the retailer to provide in-store inventory and replenishment of shelves. Furthermore, they shall guarantee sales promoting activites.

An interesting part of the sales discount is a discount for guaranteeing a certain number of items in assortment ("core items") of all stores. However, only 8 percent of suppliers signed such an agreement. This discount on sales is increasing with increasing number of items specified.

#### 3.3. Conclusions on the Power of Retailer

Regarding the category observed we concluded that the retailer exerts power to modify resulting buying prices. The contractual terms appear very homogenous in structure. There almost no individual, supplier-specific elements. Though, the conditions vary strongly in size. One reason is the type of item (private label vs. national brand). Private labels show lower discounts. The second reason is that the retailer takes as starting point the price list handed in by the supplier. Hence, somehow inflated list prices of a supplier are compensated by higher discounts. For instance, the buyer knows of buying prices of competing items within category and bargain to reach similar prices via discounts.

Though the data is not tracked we noticed from interviews that the process of bargaining that starts October each year turns out to be longer with a number of rounds if the suppliers is large. This means that large suppliers have more power to withstand commands of higher discounts. Large suppliers with strong brands (Top ten brands) are able realize lower discounts. We estimate that they have on average 12.7 percent lower discounts.

According to management the general conclusions of the structure of contracts are similar throughout all categories of the retailer. The size of discounts and promotional payments though differs.

#### 4. CONCLUSION

There is little research published on real-life contracts between suppliers and retailers (Bendl, 2000, p.14). Though we do not give individual data on suppliers we could analyse a large sample of contracts of a national retailer within its suppliers of a single category. We showed that within the consumer goods market (CPD) the hypothesis of power on the side of the suppliers is to be questioned. The academic research needs to focus analysing retail power and its consequences. For example, how suppliers can act to reach favourable agreements with powerful retailers.

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# THE INFLUENCE OF THE CONCENTRATION ON THE PERFORMANCE OF FIRMS IN RETAIL INDUSTRY IN THE REPUBLIC OF CROATIA<sup>1</sup>

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#### Abstract

According to SCP paradigm (Structure-Conduct-Performance paradigm) the industry structure affects the behaviour of firms in the industry, which affects their performance. The paradigm is consistent with the Neoclassical Theory of the Firm which assumes that there is a direct link between the industry structure, entrepreneurial conduct and performance. The basic principle of this paradigm might be the ability of entrepreneurs to exercise market power in a concentrated industry. High industry concentration is correlated with high profits, especially if the concentration level exceeds a certain critical level under the condition that there are some barriers to entry of new entrepreneurs in the industry. Economic theory supports the view that the industry concentration is in a positive relationship with efficiency, and it can be argued that the growth of industry concentration will increase the efficiency of industry. Current approaches in economic theory and recent empirical studies do not follow the SCP theory, they suggest that the above-average profits, which occur in most concentrated industry's, are results of economic efficiency and effectiveness, and not a consequence of non-competitive behaviour. In this paper we will try to give an answer to the above-mentioned issue present in economic theory. The study will try to demonstrate a statistically significant link between the measure of concentration and measure of efficiency in retail industry in the Republic of Croatia.

Key words: SCP, concentration, efficiency, retail industry

<sup>&</sup>lt;sup>1</sup> The presented results are the outcome of the project The influence of concentration and competition on the efficiency and stability of firms in the retail sector (IZIP-2016-127) conducted with the support of the Josip Juraj Strossmayer University

# 1. INTRODUCTION

Branch or industrial structure can be differentiated according to the level of its concentration, apropos of the number and the size of the companies present in the industry. The number of economic operators and the distribution of their size is the indicator of the industrial structure. The indicators of concentration are mainly derived from the achieved revenue, but the usage of other variables, which indicate the size of the company, is also possible. An industry is considered to be concentrated when a company or a small number of companies control the majority of shares in selling of the branch.

Apart from the concentration level, the industrial structure can also be differentiated according to the intensity of its competition. Two fundamental views on competition are distinguished: static and dynamic. In microeconomics, the neoclassical theory of firms is based on the static view on competition, and one of the main issues for research is the long-term balance in four different branch (industrial) structures: perfect competition, monopolistic competition, oligopoly and pure monopoly. Precisely these structures are the main issues for research of branch (industrial) organization. According to Stigler (1968), industrial organization explores the structure of companies, the influence of concentration on the competition, and the influence of competition on prices, investments and innovation. In the branch of perfect competition, a long-term balance is established where participators make normal profit while companies which do not succeed in doing so must exit the branch. Accordingly, in perfect competition, each company which prevails in the branch is equally efficient as their direct competitors. The theory of pure monopoly is developed by Marshall (1890), who was the founder of the neo-classical theory, and Sraffa (1926). A monopolist is in a significantly better position than the perfect competitor since he has the opportunity to lower his approximate cost by increasing production. By doing so, he lowers the price of the product. On the other hand, a monopolist who is exploiting his power of control of the production quantity within the branch negatively, decreases his production, increases the price of the product and damages the consumer and the society as a whole. Edward Chamberlin and Joan Robinson developed a theory of monopolistic competition and oligopoly based on perfect competition and pure monopoly, as extreme cases of the industrial structure. Monopolistic competition implies a large number of small companies within the branch which can influence the forming of the price, but solely in its short range. These companies do not make profit in the long term, but can make profit in the short term. The oligopoly structure entails few companies in its branch which, unlike perfect competition, can influence the price of their product or service. Participators understand that they depend on each other, hence the change in price and quantity of the product or service of one or the other participator will cause a reaction of other firms within the branch. Competitors within the branch of oligopoly operate based on the analysis of behaviour of other competitors, the war of prices, which would harm all participators on the market, is being avoided.

Therefore, high concentration branches, oligopoly and pure monopoly, can either fully or partially influence the price of their product, and can thereby also influence the level of gained economic profit, which leads to the conclusion that they are more efficient than the rest of the branch structures. This view on concentrated branches, which is characteristic for the neo-classical school, has its foundation in the empirical work of Bain (1951). Regression of profitability on business, which is shown in Bain's work, clearly shows that businesses with a higher concentration level achieve a higher profit. In other words, Bain arrives to the conclusion that limiting the concentration by the state's intervention benefits the customers more than it harms the manufacturers, and contributes to a higher level of social welfare and a lower efficiency of the manufacturers.

Efficiency is a broad economic term which has found its use in various areas of action of economic operators. Recent literature entails several terms and various definitions of efficiency. In his book Karić (2006, p.39) mentions how efficiency "as a form of successfulness of the business, maximizes the production or minimizes the spending of deficient resources. It expresses the successfulness in relation to used resources and measures the ratio between results and investments." This term is similarly defined by Mankiw (2006), efficiency is the ability of the society to maximize the output from the available and deficient resources. We can conclude that the efficiency is higher the more favorable the ratio between the accomplished output and input is, in other words it is higher when the same costs achieve a greater result or when the same results are achieved with a lower cost. Thus, the bigger the difference between sales revenue and cost of sold goods is, the more efficient will be the companies, which operate in the retail industry. The two main forms of efficiency are technical efficiency and economic efficiency. Technical efficiency is the ability of the economic operator to manufacture a physical unit of output with the least input of assets and time, while economic efficiency is the ability of the economic operator to produce and sell as valuable output as possible with the least cost. This research will focus on economic efficiency, while technical efficiency will be measured in future research.

As previously stated, we can conclude that the classical economic theory presumes a positive correlation between concentration and efficiency even though there is certain empirical evidence which confirms that it does not always have to be true. Within the scope of this research, we will explore the condition of the sector of retail in the Republic of Croatia.

# 2. METHODOLOGY

According to the previously stated and presented correlation between the efficiency level, the intensity of the competition and the concentration level, it seems reasonable and scientifically justified to explore the correlation between the efficiency level and the concentration level, which can positively and directly influence the understanding of the correlation between mentioned terms. Within the context of all previously mentioned, a basic hypothesis, which is in accordance with the classical economic theory, has been defined:

H1: The efficiency of companies in the retail industry is in a positive correlation with the concentration level.

This research is based on an unstructured measure. The main advantage of unstructured measures is their behaviouristic approach towards individual subjects which allows the measuring of the branch power and the efficiency for each subject individually. In order to prove the main hypothesis in the research, panel data of the retail industry of the Republic of Croatia is used, which entails twelve largest firms (measured by their achieved revenue). The research covered the period from 2010 until 2015. In the research, we used the data available from the Financial Agency (FINA), thus the research is based on a secondary source of data.

In order to accept or reject the set hypothesis, one of the measures of efficiency will have to be put into correlation with a certain chosen measure of concentration. As a measure of concentration, we will use the Concentration coefficient of the n largest firms within the industry (CR<sub>n</sub>). This measure is mostly measured for the four largest companies within the industry, but can also be used for six, eight or more largest companies. The procedure of calculating the concentration coefficient is based on the sum of individual market shares for n of the largest companies within the industry. The concentration coefficient is the percentage of the share of a certain variable (income, assets, capital...) of the n largest companies from the total value of the industry and is determined by the following expression:

$$CR_n = \sum_{i=1}^n s_i \tag{1}$$

where the  $s_i$  is percentage share of firm *i* in the total value of the branch. In this paper authors use income as a variable by which we determine the concentration level. The smaller the concentration coefficient in a given branch the concentration is lower. With this benchmark, the level of concentration and type of market structure can be determined. The biggest disadvantage of this benchmark is that it ignores the impact of small business in the branch because it places the emphasis on the shares of the largest companies. The concentration coefficient value ranges between 0 and 100. By using the coefficient of concentration, we can distinguish four basic market structures:

- perfect competition,  $CR4 \approx 0$
- monopolistic competition, CR4 < 50</li>
- oligopoly, CR4 > 50
- monopoly,  $CR4 \approx 100$

The research is based on the model which Salinger (1990) applied in his work. Regression models based on postulates from the classical economic theory (SCP theory) often use the profitability (efficiency) for the dependent variable, and some form of concentration is used for the independent variable. So, some models that want to test the Cournot model oligopoly, or equilibrium, use the following equation:

$$L = \frac{HHI}{\delta}$$
(2)

where: L is Lerner index<sup>2</sup>, H is Herfindahl-Hirschman index<sup>3</sup>, and  $\delta$  is Price elasticity of demand. If we assume that the price-cost margin (PCM) is approximate to the

<sup>&</sup>lt;sup>2</sup> The Lerner index measures the relative margin which is an indicator of total power. It is defined by the expression L = (P - MC) / P, where P - is the price of the product and the MC - the marginal cost.

<sup>&</sup>lt;sup>3</sup> The Herfindahl-Hirschman Index (HHI) measures the degree of concentration on the market by adding squares of market shares of all companies present on the market. It is defined by the following mathematical expression: HHI =  $\Sigma$  s<sup>2</sup> where *s* is the share of a single enterprise.

Lerner index<sup>4</sup>, and the Herfindahl-Hirschman index (HHI) as a concentration measure is replaced by another concentration measure, for, example Concentration coefficient of the four largest companies (CR4) then the equation (2) can be written as follows:

$$\mathbf{n} \mathbf{PCM} = \alpha_0 + \alpha_1 \mathbf{In} \mathbf{CR4} + \alpha_2 \mathbf{In} \,\delta + \varepsilon_1 \tag{3}$$

where  $\varepsilon$  is a stochastic variable representing unsystematic impacts on the dependent variables. By applying the third equation we can reject the Cournot oligopoly by rejecting a common hypothesis where it is  $\alpha_0 = 0$ ,  $\alpha_1 = 1/k$ ,  $\alpha_2 = 1$ . In the case of not knowing the elasticity of demand Salinger (1990) states that we can use the following statement:

$$PCM = \beta_0 + \beta_1 CR4 + \varepsilon_2 \tag{4}$$

where  $\beta_1$  is an average value of  $1 / k\delta$ , while PCM is the average margin in retail trade. In our research we use this equation to measure the impact of concentration on company efficiency. In order to verify and confirm the results obtained using the regression model shown in equation four (4), we decided to implement another regression model in which the concentration coefficient of the six largest companies in the branch would be used for the concentration measure, and we will quote it below:

$$PCM = \beta_0 + \beta_1 CR6 + \varepsilon_2$$
(5)

where CR6 is the concentration coefficient of the six largest companies in the branch. Using the previous statements made by Salinger for research purposes, we have constructed the following model:

$$\mathbf{PCM}_{\mathbf{i},t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \mathbf{MS}_{\mathbf{i},t} + \boldsymbol{\varepsilon}_{\mathbf{i},t} \tag{6}$$

where  $PCM_{i,t}$  is company margin *i* in year *t*;  $MSI_{i,t}$  is company share *i* in year *t*. The model represented by the equation six (6) was computed using the computer using the econometric program. For the calculation of the model, we used a linear model of fixed effects.

It is necessary to verify the dependent variable. The margin or price difference of goods is in fact the earning of the company which operates in the retail industry for the purpose of covering their sales expenses and achieving profit. Lipczynski et al. (2005) specify five different variables of efficiency. One of the variables is productive and allocative efficiency which, according to them, is the ability of the company to produce given units of output with the least cost of input. In the given context, margin can be treated as a certain measure of company efficiency which operates in the retail industry since its input is the cost of sold goods and its output is the revenue of sold goods. The bigger the difference between sales revenue and costs of sold goods is, the higher the margin will be, which means the company is more efficient. The margin has been calculated in the following way, from the profit and loss account, costs of sold goods have been subtracted from the sales revenue, and then the calculated margin was divided by the sales revenue in order to gain its relative value.

#### 3. RESULTS OF THE RESEARCH

<sup>&</sup>lt;sup>4</sup> For the long-term Lerner index, this approximation is based on the implication of the assumption that the average cost is equal to the marginal cost, within a short time that the marginal cost equals the average variable cost.

A logical question has been asked at the beginning of the research: What has been happening to the concentration level in the observed six-year period? The concentration level has been measured by the concentration coefficient of four and six companies within the branch, and the result is shown in table 1. The concentration, which was measured by the concentration coefficient of four largest companies within the industry, points out the trend of concentration growth within the retail industry. Even though during the observed period in 2012 and 2013 a slight stagnation was noted, it was later eliminated. Almost the same result was extracted by the concentration coefficient of six largest companies within the industry. During the observed period, an ascending trend with a slight reduction of concentration in 2012 is noted. Hence, the analysis of presented results clearly states that the retail industry in the Republic of Croatia belongs to the oligopoly market and the concentration coefficient of four and six companies in the industry is always higher than 50%. The industry is extremely concentrated, six largest companies have 85% of revenue of the entire branch at their disposal.

Year	CR4	CR6
2010	62,87%	74,70%
2011	63,70%	75,12%
2012	63,31%	73,71%
2013	63,29%	74,14%
2014	65,79%	77,30%
2015	71,81%	84,49%

Table 1: Coefficients of concentration in research period

Source: Authors calculation

With the help of the regression model, which was presented in equation four, we have evaluated the correlation between the margin and the concentration coefficient of four largest companies within the industry. By analysing the results which were presented in table 2, we come to the conclusion that there is a positive correlation between the size of the margin and the concentration level within the branch. The value of the coefficient  $\beta_1$  is 0,27, while its related p-value is 0,033, which indicates a statistically significant result. The constant of the set model is 0,01 with the belonging p-value of 0,85, the result of the constant value was not statistically significant.

**Table 2**: Research results for linear regression model by margin and concentration coefficient of four largest companies

	Value of coefficient	Standard Error	t- test	p-value	95% confidence interval	
CR4	0,271812	0,085116	3,19	0,033	0,035491	0,508133
constant	0,010626	0,055497	0,19	0,857	0,0518902	0,164713

Source: Authors calculation

The equation four and equation five are closely related, the only difference is that in equation five we use the concentration coefficient of six largest companies within the branch as an independent variable. Hereby we merely wanted to prove and confirm the results gotten by using equation four. The gotten results confirm the previously presented results from table 2. The concentration coefficient of six largest companies within the branch is in а positive correlation with the company's margin ( $\beta_1 = 0.23$ ), but this correlation is slightly weaker than the correlation of margin and the concentration coefficient of four companies within the branch. The p-value for the calculated coefficient is 0.03 which indicates the statistically significant result. Nevertheless, what should be emphasized is that the pvalue of the constant is 0.85, similarly with the previous regression from equation four, which indicates a statistically insignificant result.

**Table 3**: Research results for linear regression model by margin and concentration coefficient of six largest companies

	Value of coefficient	Standard Error	t- test	p-value	95% confidence interval	
CR6	0,231076	0,070045	3,30	0,030	0,036598	0,425553
constant	0,010628	0,053702	0,20	0,852	-0,138403	0,159799

Source: Authors calculation

The equation six was applied to our panel data which entails 72 observations in total, divided in twelve groups. The results of the research indicate a strong correlation between the dependent and independent variable. The coefficient  $\beta_1$  is 0,9235 which leads to the conclusion that every increase of the market share of one percent influences the growth of margin for 0,92%. Using the p-value we have tested the hypothesis that the coefficient is different than zero. Since its value is less than 0,05 we can conclude that the mentioned hypothesis is rejected on the level of significance of 5%. Furthermore, we have conducted a t-test which tested the hypothesis that the achieved result of the coefficient is different than zero. Since its value is greater than 1,96 (the interval of reliability is 95%) we can also reject the previous hypothesis.

The value of the constant  $\beta_0$  is 0,114 and we have tested the hypothesis that its value is different than zero by using p-value and t-test. P-value is 0,001, while the value of the t-test is 3,66. Thus, both tests confirm the statistical significance of gotten results for both coefficient  $\beta_1$  and  $\beta_0$ . The results of the research are presented in table 4.

	Value of coefficient	Standard Error	t- test	p-value	95% confidence interval	
MS	0,9235261	0,3627526	2,35	0,022	0,13763	1,709422
constant	0,1144576	0,0312681	3,66	0,001	0,0518902	0,177025

Table 4: Research results for linear regression model by efficiency and market share

Source: Authors calculation

# 4. **DISCUSSION**

The presented empirical evidence points out the existence of a positive correlation between the level of efficiency and the branch concentration. Therefore, the hypothesis of this research can be accepted. Furthermore, the SCP paradigm assumes a positive correlation between the concentration and efficiency, this research affirmed this thesis. Certain authors do not agree with this statement, such as Demirguc-Kunt and Levine (2000). They believe that the correlation between concentration and efficiency does not show statistically significant, positive nor negative, correlation. Apart from the positive correlation between the concentration and efficiency, it has been proven that the growth of efficiency is possible within the conditions of competition growth, and the achieved results are in accordance with the research conducted by Schaeck and Čihak (2008, p.20). Hence, the empirical evidence from this research indicates the conclusion that the efficiency of the branch is in a positive correlation with the concentration, which is in accordance with the set hypothesis (H1). The reason for this condition within the branch can be seen from the fact that with the increase of the intensity of competition, less efficient companies are forced to abandon the branch, while more efficient companies which remained in the branch are increasing their level of efficiency on account of inefficient companies which abandoned that branch. In addition, it is more likely that the more efficient companies are taking over less efficient companies. In the last couple of years, we have witnessed the consolidation and takeover within the retail industry in the Republic of Croatia. Moreover, the increase of concentration level in the retail industry causes, apart from the exit of less efficient companies from the branch, the rejection of other companies to enter the branch, which leads to the reduction of companies within the branch and to the increase of general concentration level.

While interpreting the results of the research we should be careful since the model entails certain imperfections and deficiencies. Firstly, we would like to point out the margin as a form of company efficiency. The margin can also be connected to the intensity of market position of a certain company. Companies that have monopoly power can influence the price of their product. It corresponds to the fact that companies, which operate in the retail industry in that case, have the opportunity to increase the difference between sales revenue and the cost of sold goods. In other words, they can calculate a higher price for the products that they are selling. Even though the advantage of the margin as company efficiency, which operates in the retail industry, is the fact that most of the revenues and costs are brought forth by the goods they sell, it should not be forgotten that companies which can reduce other costs (for example costs of financing, capital investment costs...) can be more efficient than companies which have a higher margin.

# 5. CONCLUSION

By analysing the results of the research presented in this paper we conclude that the efficiency and level of concentration are positive related. We compared the relationship between these two variables using three models. The two models were based on data for the entire retail branch, while one model was based on individual data, separately for each company. Thus, aggregated and individual data results in a similar outcome. As the branch is more concentrated, companies operate more efficiently, this research result is in line with neoclassical theory. Hence, larger companies are more efficient because they can better use the benefits of economies of scale. The purpose of this research was not to overcome the generally accepted economic postulates, but to remove the doubts that have arisen in some previous research.

The research, that is carried out in this paper, has its own limitations, which is primarily reflected in the interpretation of the margin as a kind of efficiency measure. In future studies, it is necessary to measure efficiency with unconventional methods such as *Stochastic Frontier Analysis* (SFA). The application of this method poses some other problems, which are primarily manifested in the lack of necessary data. This method starts from the company's revenue function and measures its (non)efficiency. The authors hope that they will be able to carry out the research in the future, whose results could better explain the results of the research presented in this paper.

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# THE IMPORTANCE AND DEVELOPMENT FACTORS OF RETAIL BUSINESS LOGISTICS - THE CASE OF THE REPUBLIC OF CROATIA

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#### Abstract

The motive for this work is a mismatch between the significance of trade (especially retail trade) according to its share in the number of employees, in the turnover, etc. in the overall economy, and its importance as a driver of supply chains and economic development in the Republic of Croatia. In the last twenty years there is an evident development of retail companies in quantitative terms (increase of sales area), but the insufficient development in qualitative terms of using modern technical and technological achievements and connectivity in the regional value adding chains. Based on available literature, the paper provides an indication of the importance and factors of development of business logistics of retail companies. Developing of retail supply chains have gained attention to the importance of retail in the management of economic processes. This paper analyzes the available statistical data (for the period of the last twenty years) on the movement of the importance of retailing in the Republic of Croatia (on the basis of its share in the overall economy) and information relating to the development factors of retail business logistics (choice of location, format of retail business units, supplier structure, market and competition, technical and technological environment, political and legal factors, etc.). Based on the importance of logistics for retail companies in national economy, the aim of this paper is to evaluate the importance of retail and the role of retail companies in the development of the national economy of the Republic of Croatia. The aim of this study are knowledge of new logistical viewpoints to the importance of retailing in the (un)successful development of the national economy of the Republic of Croatian, and respectively regional value adding chains. The work has the purpose to point out the importance of business logistics for the success of the retailer, but also the significance of the impact of internal and external factors on the development of its logistics business. Limitations of this study are related to recent statistics data. In addition, there are further more specific research needs of individual supply chains.

**Key words:** retail company, business logistics, supply chain, format of retail business unit, Republic of Croatia

# 1. INTRODUCTION

Importance of business logistics of retail companies arises primarily from the importance of the function of trade as economic activity. An increase in the importance of business logistics can be analyzed on the basis of essential changes that are related to flows and the use of goods and information within the supply chain within the company itself, as well as within the supply chains that cross the company boundaries. These changes are also the factors behind the development business logistics of retail companies. They can be analyzed based on selected trends.

In this paper, based on the available literature, notes about trade, retail and logistics, as well as the importance and factors of the development of business logistics of retail companies are given. Then, based on the available statistical data (Central Bureau of Statistics of the Republic of Croatia, Eurostat, Deloitte, GfK), the following analysis for the Republic of Croatia are given:

- a. some specificities of the development and importance of retail companies and all distributive trades in the national economy;
- b. formats of retail business units;
- c. online retailing.

Selected data on the development of retail companies for the Republic of Croatia, analyzed for the last decade, refer to the total retail and, in particular, retail store sales: turnover, sales area and number of employees. Data on the importance of retail companies and the entire distributive trade of selected European countries (including the Republic of Croatia) refer to 2014 and 2015. Particularly important are data on large retail chains as drivers of supply chain. Data for the Republic of Croatia on the forms of retail business units and the online retail as essential factors of development of business logistics of retail companies relate to 2014 and 2015. Our analysis includes the following European countries: Austria (AT), Finland (FI), Italy (IT), Germany (DE), United Kingdom (UK), Bulgaria (BG), Estonia (EE), Croatia (HR), Hungary (HU) and Poland (PL). In particular, as countries of origin of retail companies that are among the 250 largest in the world in 2015 are indicated: Germany (DE), France (FR), United Kingdom (GB), Netherlands (NL), Spain (ES), Belgium (BE), Switzerland (CH), Russia (RU), Sweden (SE), Portugal (PT), Italy (IT), Finland (FI) Austria (AT), Denmark (DK), Norway (NO) and Croatia (HR).

The purpose of this paper is to point to the importance of business logistics for the success of a retail company, and then to certain disparities in the development of distributive trade, i.e. retail companies (as supply chain starters) with the level of economic development in the Republic of Croatia.

# 2. RETAIL COMPANY AND TRADE LOGISTICS

The importance of business logistics of retail companies can be analyzed by looking at the importance of business logistics in total trade (trade logistics), as large retail companies have also taken on wholesale trade functions, especially space and time overcoming functions, as well as quantity, assortment and qualitative regrouping of goods. For this purpose, in this paper we will use the term "distributive trade" (according to Eurostat). According to NACE (Rev 2, 2008, p. 217) distributive trade includes wholesale and retail sale (i.e. sale without transformation) of any type of goods, and rendering services incidental to the sale of merchandise. Thus, in the case of wholesale trade, buyers are those recipients who use these goods for further economic activity, and in retail trade it is about serving a final consumer or a final customer as a buyer (cf. Lerchenmüller, 2003, p. 19). However, there are difficulties in delimiting retail trade from the wholesale trade.

Data from Eurostat (according to NACE, Rev 2, 2008) refer to total distributive trade (Section G – Wholesale and retail trade; repair of motor vehicles and motorcycles), and its components:

- Division 45 Wholesale and retail trade and repair of motor vehicles and motorcycles;
- Division 46 Wholesale trade, except of motor vehicles and motorcycles
- Division 47 Retail trade, except of motor vehicles and motorcycles.

Retail company is important in institutional classification of trade (cf. Müller-Hagedorn, 2005, p. 3); but it develops a trade logistics that crosses boundaries of retailing itself. Our starting point definition of trade logistics is<sup>1</sup>: *Trade logistics is integrated management of all goods and related goods flows between the trading company and its suppliers, within the trading company and between the trading company and its customers*. As a component of trade logistics could be taken (Groß et al., 2014, str. 350 – 355):

- a. standard services in each delivery path structure
- b. special services that add value.

The first group of services is realized in: procurement logistics, warehouse logistics, distribution logistics and store logistics. Second group of services is additional and often associated with standard services. Therefore, it can be realized in a packet with the first group. This group also includes management services within new business models. These are related to new technologies and special infrastructure, the use of know-how and especially the extra-educated staff. For the contemporary trade logistics, the following can be determined (Wirtschaftslexikon, 2016.): *Logistics in the trade consists of the area of internal logistics of supply, distribution and disposal, which is especially important for the trade that connects production with the purpose of profiling in competition. Through a new development in its environment (increased environmental awareness, user requirements for the introduction of the JIT system), the trade is forced to clearly define its service level and hence to its outlined strategy, most often pursuing the goal of achieving one profiling in delivery service.* 

In this linkage of parts of companies, suppliers and buyers, networks are creating in which the economic importance of logistics can be described on the basis of changes in three areas: (a) cost structure; (b) markets, and (c) risks. Of course, all this is happening in the development of globalization processes, as well as in the processes of developing new technologies (see Petzinna, 2007, p. 21 and cit.).

<sup>&</sup>lt;sup>1</sup> Developed based on Kotzab (2003) cf. Begriffe im zentralen Glossar, 2005.

# 3. TRADE FUNCTIONS AND IMPORTANCE OF TRADE LOGISTICS

The importance of trade logistics derives primarily from the importance of trade as an economic activity, and then from its role in the success of the trading company's performance. In this regard, shares of trade in value creation in individual national economies are very important, as well as share of logistical costs in the total costs of the trading company. Logistics is of particular importance in the development of large international retail companies which in today's supply chains, e.g. in the grocery sector, have the greatest power (Dujak, 2012). The term "retail supply chain" indicates a situation where a major retailer (retail chain) dominates in the supply chain.

Based on the historical analysis of trade development as an economic activity, conclusions have been reached about the constant increase of its significance with regard to the spatial and temporal distances of production from consumption, the increasing specialization of production and the provision of ever increasing differences in consumption. In this sense, trade functions have been constantly evolving. So the starting point for understanding logistics in the trade is studying about the functions of the store. Here, above all, the functions of overcoming space and time, regrouping goods by quantity, creating choices (assortments) and recruiting goods by quality should be specified. Trade functions are part of distribution functions, which relate to the bridging of spatial, temporal, quantitative and qualitative differences between production and consumption, in order to carry out goods traffic (see Ahlert, 1985, p. 11). But distribution functions are not only performed by trade companies, but also by manufacturers and consumers alike. In that sense, the integrated and unintegrated distribution channel types differ. Namely, distribution channels are all those organizations that the product has to pass between its production and consumption (Kotler/Wong/Saunders/Armstrong, 2006, p. 858). Distribution channels have already been labelled as "marketing channels" in marketing terms, as channel members are associated with multiple streams and exist (Kotler & Keller, 2006, p. 473; Kotler et al., 2005, p. 861). ): physical flow, ownership flow, payment trnasaction flow, flow of information and promotion flow.

Starting from the function of marketing channels (Kotler, 1997, pp. 531-533), the trading functions could be divided into two areas (Segetlija et al., 2011, p. 44): field of physical distribution and marketing field. Functions in the field of physical distribution are logistics function, as they relate to trade activities in the distribution channel.

Of course, the main task of the trade is to execute its assortment function, as it connects the products offer of different manufacturers to a comprehensive assortment with benefits for consumers. This reduces the cost of order processing, which would arise when the customer specifically ordered each product separately. In addition, small quantities sale is avoided and consumers can access different types of goods in one place. In this regard, the costs for consumers are also reduced due to the intermediary trade function that it fulfils with the parallel offer of competing products of different manufacturers. The time between production and consumption is overcome by the storage function.

For a retail company it is necessary to point out that through its activity it ends the exchange phase of the economic process from which the goods passes into the consumption phase. In the modern concentration processes large retail companies are being developed, which have also taken over the wholesale trade functions as already mentioned. So nowadays huge retailers pull goods directly from manufacturers, but on the other hand, direct distribution through online sale is getting growing importance. To many of the manufacturers, only the online store allowed direct sales to final consumers. However, direct sales are not negligible even through its own stores. Such stores are, e.g., *flagship stores*, as exclusive and unique brand stores in big cities.

From all of the above, it can be seen that logistics is the central trade competence (see Handelslogistik: Vier Stellhebel bestimmen den Erfolg, 2014). The importance of logistics in the trade is steadily increasing because of the fact that it develops in terms of flow management (see Krieger, 2017). Importance of trade logistics, i.e. logistics of a retail company, can be expressed according to the share of logistical costs.

# 4. FACTORS OF TRADE LOGISTICS DEVELOPMENT

Factors determining the logistics of a retail company could be divided into (see Teller & Kotzab, 2002, p. 9 and cit.) external and internal. External factors include: supplier structure (number and size of supplier), competitive conditions (type of competitors, competition between individual formats of business units) and technological environment (introduction of information technology within the company and within the supply chain, political and legal factors). The internal factors of retail logistics are: location strategy (network of locations, business units formats and logistics infrastructure) and assortment strategy (range and depth of assortment, supply of space on the shelves). From the above-mentioned factors of business logistics, the decision-making parameters are performed, to set goals and define the strategies. It is considered that the greatest impact on reaching of present highest stage of business logistics is achieved by the development of the global economy in terms of business globalization in both production and distribution (Göpfert, 2006, p. 52).

Factors for the development of trade logistics can be analyzed based on trends in its environment (see Groß et al., 2014, pp. 360-363). These incentives that come from outside the profession, motivate trade for the further development of internet and cross-channel retailing. Of course, some incentives for such development may come from the trade profession itself. The new technical and technological opportunities are used not only to achieve short-term success but also to long-term commitment. In this respect, it is important to point out that the new technical and technological requirements need to be adapted to all business areas of the retail company (not just logistical). Based on the latest professional publications, six key trends can be highlighted under current conditions – they represent drivers of trade and trade logistics in all segments, which will probably play the significant role in the future. These trends change requirements on trade logistics in terms of increasing logistics quality, flexibility and efficiency, and often innovativeness. These trends can be mentioned as follows (see Groß et al., 2014, p. 361 ff.): increased traffic in ecommerce, the growth of private commerce (trading for own account) through the mobile Internet, increasing customer requirements, demographic changes, increasing pressure on costs and the growing importance of sustainability in running the company.

Trade logistics will certainly develop on the basis of further development of online retailing and trading of individuals for their own account, and new ways of delivering goods to consumers in terms of aggregating (linking) shipment with regard to delivery routes will also need to be developed. Customer requirements are increasing in terms of the quality of the logistics service, especially keeping the delivery deadlines as well as shortening the delivery deadlines (24 hours delivery is developing). Demographic changes like population aging and changes in population structure affect and changes the purchasing behaviour (e.g. because of the difficulties in the personal supply of the elderly). Cost pressures are most apparent in energy consumption and prices, but also in the increase in total transport. However, pressures on costs also appear as competitive pressures, as prices have to be competitive.

Sustainability requirements primarily refer to retail products and services through corporate social responsibility. It is connected to the adjustment of technical and technological progress and the development of awareness of necessity for socalled green logistics. Globalization trends and new technologies affect changes in the cost structure and their reduction. Cost pressures occur through the development of market relations. Of course, the importance of business logistics is also increasing due to the growing risk taken by the companies, as market demands are becoming more complex, dynamic and less predictable.

In the expanded food sector, grocery sector (de. *Lebensmittel*), seven consumer trends and their impact on business logistics can be highlighted (Nitsche & Fiegel, 2016, str. 10 - 26): e-commerce/home delivery; transparency; seasonal and regional products; convenience food; food waste awareness; convenience stores; and labels "bio" and "fair".

The trend of constant expansion of e-commerce is also important in the grocery sector. For retail logistics, this factor is important due to delivering into the consumers' home. Their requirements also apply to shorter (or targeted) delivery times. Logistics requirements are increasing especially due to the need to develop *omni-*, i.e. *cross channel* logistic. Transparency requirements across the entire supply chain relate to data on product origin and production conditions, as well as transportation, warehousing and further processing of all components entering the certain product. In this sense, essential requirements relate to quality and traceability.

Logistics requirements are also increased due to consumer awareness of sustainable and healthy diet, whereby seasonal and regional products are particularly interesting. By this, an earlier approach of the offer of individual food products throughout the year and at all locations is abandoned. In such efforts raises the importance of smaller regional food producers, which need to be logistically connected. Retail logistics is also affected by the growing demand for semi-finished and ready-to-eat foods, ready for consumption. In the offer of such products the important role have the appropriate delivery speed, special packaging, etc., depending on the nature of the product (deep-frozen products, fresh products, semi-snacks). A special factor in the development of logistics is the growing awareness of consumers

about losses, i.e. food waste along the entire supply chain. Losses are related to the produced food products, but also to the losses in production and delivery processes.

The trend of Convenience Stores development is related to daily goods stores near the consumers' home, which have less sales area, a more modest product range and faster inventory turnover than traditional stores in the grocery sector. This trend is related to demographic change (population aging) and the growing number of one member families. Gas stations are often classified in this group of stores. The development of bio-products sold in convenience stores and bio-supermarkets is reflected in the development of business logistics, because in this way smaller quantities are taken from suppliers and transport is decentralized.

#### 5. NEW FORMS OF RETAIL BUSINESS UNITS

Contemporary technical and technological achievements, related to information and communication technologies, have also led to new forms of retail business units, because today the marketing channel characteristics are their main characteristics. Due to e-commerce, marketing channels are enriched with new product and information flows. First of all, new development processes have led the classical retailer to become a cross-channel retailer, and additional supply options of final or business customers were also available for both the manufacturer and the wholesaler. In addition, in the processes of new specialization, the development opportunities were also provided to logistics service companies and supply chains are particularly enriched with new packaging and delivery services. In this sense, supply chains developed within the new retail network with other participants (see Groß et al., 2014, p. 337, 349). Therefore, it is about new business models.

Regarding this, it should be pointed out that a retailer, e.g. in the grocery sector, develops the two most commonly used models (see Nitsche & Fiegel, 2016, pp. 8, 9): online supermarkets and pre-commissioned box providers.

Online supermarkets do not have any sales area, they use a web platform, and deliver goods to customers from one or more warehouse locations. Such supermarkets are specialized or are full product range suppliers in the grocery sector.

Pre-commissioned box providers offer packages of selected products, such as sweets. However, convenience food boxes relate to the selected meal time and convenient delivery of the product for that time.

Due to the digitalization development and demographic changes in the European Union, sales area will be reduced. It is anticipated that in the European Union the current approximately 590 million  $m^2$  of sales area will be reduced to approx. 510 to 550 million  $m^2$  by 2030 (Europäischer Einzelhandel: Konsolidierung bis 2030 - Flächenrückgang um zehn Prozent, 2016).

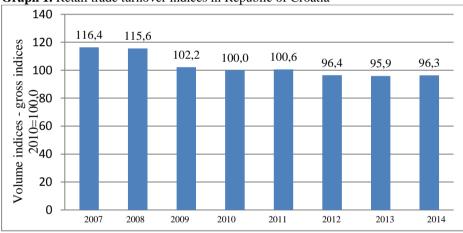
# 6. ANALYSIS OF SELECTED INDICATORS - SPECIFICS OF THE REPUBLIC OF CROATIA

In assessing the importance of retail companies and their business logistics in the Republic of Croatia there are certain specifics. Therefore, this paper analyses the following:

- (a) the development and importance of retail companies;
- (b) forms of retail business units and online retailers.

# 6.1. Development and importance of retail companies

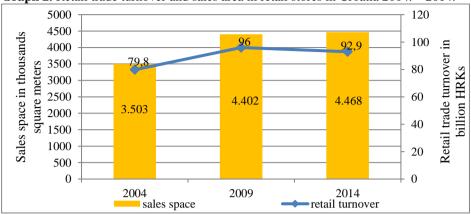
The development of retail trade in the Republic of Croatia for the period 2007 - 2014 can be seen in graph 1, showing real turnover indices in total retail trade (regardless of the predominant activity of the business entity). Given the economic downturn that prevailed over this period, retail trade turnover in 2014 was 17.3% lower than in 2007.



Graph 1. Retail trade turnover indices in Republic of Croatia

Source: SLJH 2015, p. 436, Central Bureau of Statistics of the Republic of Croatia, Zagreb.

Turnover trends in retail trade in the Republic of Croatia for a slightly longer period 2004 - 2014 are shown in graphs 2 and 3. It is obvious that retail trade turnover in the Republic of Croatia had a strong expansion since in the period 2004-2014 it grew by 16.4%, sales area by 27.5% and number of employees by 18.0%. However, in the period 2009 - 2014 retail turnover also decreased.



Graph 2. Retail trade turnover and sales area in retail stores in Croatia 2004. – 2014.

Annotation: (a) sales area in thousands square meter; (b) retail trade turnover in billions of HRKs; (c) turnover per price in 2004 (a nominal turnover corrected, with the retail price indices); (d) without kiosks and open- air sale areas.

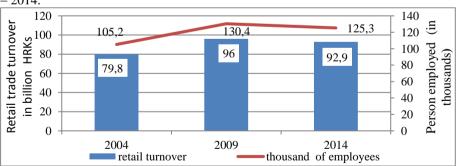
Sources: (a) Prodajni kapaciteti u trgovini na malo u 2004., Statistička izvješća 1293., Central Bureau of Statistics of the Republic of Croatia, Zagreb, 2006.

(b) Prodajni kapaciteti u trgovini na malo u 2009., Priopćenje Br. 4.1.3. od 28. travnja 2011., Central Bureau of Statistics of the Republic of Croatia, Zagreb.

© Prodajni kapaciteti u trgovini na malo u 2014., Priopćenje, Br. 4.1.3. od 28. travnja 2016., Central Bureau of Statistics of the Republic of Croatia, Zagreb.

(d) Mjesečno statističko izvješće, Razni brojevi, Central Bureau of Statistics of the Republic of Croatia, Zagreb.

(e) SLJH, Razna godišta, Central Bureau of Statistics of the Republic of Croatia, Zagreb.



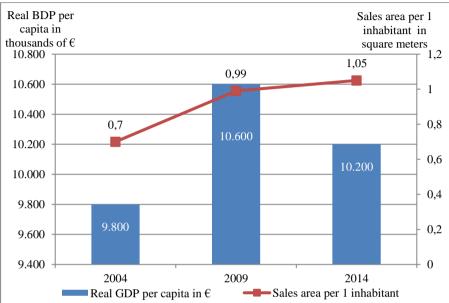
**Graph 3.** Retail trade turnover and person employed in retail stores in Croatia 2004. – 2014.

Annotation: (s) turnover per price in 2004 (a nominal turnover corrected, with the retail price indices); (b)without kiosks and open- air sale areas. Sources: As in Graph 1.

The development of retail trade in the period 2004 - 2014 was stronger than the development of the overall economy. Thus, while the sales area per capita in the observed period 2004 - 2014 increased by 32.9%, the GDP per capita increased by

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only 4.1%. This is visible from the graph 4. These trends are a reflection of uncoordinated economic development.



**Graph 4.** Sales area per 1 inhabitant and GDP per capita in Republic of Croatia 2004 - 2014

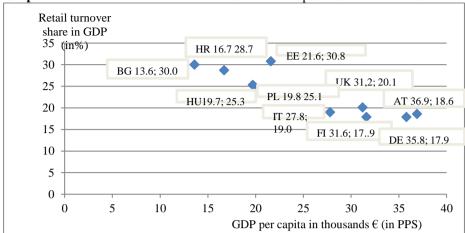
Sources: (a) Real GDP per capita, growth rate and totals, Eurostat, 2017.

(b) Prodajni kapaciteti u trgovini na malo u 2004., Statistička izvješća 1293., Central Bureau of Statistics of the Republic of Croatia,Zagreb, 2006.

(c) Prodajni kapaciteti u trgovini na malo u 2009., Priopćenje Br. 4.1.3. od 28.travnja 2011., Central Bureau of Statistics of the Republic of Croatia, Zagreb.

(d) Prodajni kapaciteti u trgovini na malo u 2014., Priopćenje, Br. 4.1.3. od 28.travnja 2016., Central Bureau of Statistics of the Republic of Croatia, Zagreb

The importance of retail companies and overall distributive trade in national economies of selected European countries is shown in graphs 5, 6 and 7. Graph 5 shows the share of retail turnover in GDP. One can see that the transition countries (especially Bulgaria, Croatia and Estonia) have larger shares of retail turnover in GDP, although at the same time achieving significantly lower levels of GDP per capita. It is also seen that with such growth, retail turnover in the Republic of Croatia reaches 28.7% of GDP. This is a reflection of the already mentioned uncoordinated economic development.



Graph 5. Retail turnover share in GDP in selected European Countries in 2015

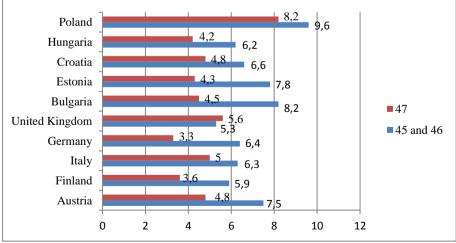
Annotations: PPS – Purchases Power Standard: BG - GDP provisional; PL – GDP estimated Sources: a) Main GDP aggregates per capita, Eurostat, 2017.

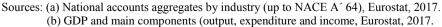
b) Annual detailed enterprise statistics for trade (NACE Rev.2 G), Eurostat, 2017.

c) GDP and main components (output, expenditure and income), Eurostat, 2017.

The importance of distributive trade (and retail trade within it) can be analyzed by the share of gross added value, i.e. by the share of employees of all activities in a particular country. Graph 6 shows the gross added value of retail turnover and other distributive trade in the total gross added value of all activities in the selected European countries 2014.

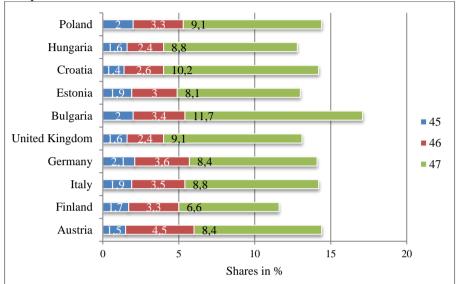
**Graph 6.** Gross value added share in total NACE activities in selected European Countries in 2014 (in %)





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Distributive trade shares in the total number of employees in all activities in selected European countries for 2015 are shown in graph 7.



**Graph 7.** Distributive trade shares in total number of employees in selected European Countries 2015

Annotation: + 15 years and over

Sources (a) Employment by sex, age and economic activity (from 2008 onwards. NACE Rev. 2) - 1.000, Eurostat, 2017.

(b) Employment by sex, age and detailed economic activity (from 2008 onwards. NACE Rev. 2 two digit level) -1.000, Eurostat, 2017.

Particular importance of large retail companies and their activities is in the supply chain management and in the introduction of modern forms of retail business units and online retailing. Therefore, data on concentration in distributive trade are important. According to the State of the market for retail trade in grocery sector, mainly food, beverages and home hygiene products in the Republic of Croatia in 2015 (Croatian Competition Agency), the top 10 retail companies participated on the market with more than 80%. Among them were four foreign retailers.

The specificity of the Republic of Croatia is that only four retail companies from the Republic of Croatia enter the 500 largest companies of the Central and Eastern European countries in 2015. These are: Konzum d.d., Lidl HRVATSKA d.o.o.k.d., Plodine d.d. and Kaufland Hrvatska k.d. (Ranking Coface CEE Top-500 companies, 2016). Furthermore, among 250 largest retail companies in the world in 2015 entered one from the Republic of Croatia (Agrokor d.d., which also includes Konzum d.d.). Countries with the largest retail companies in the world, which are among the top 250, are shown in table 1.

Table 1. European Countries with the Largest Retailers 2015								
Country	Number of	Number of	Share of Top					
	companies	single	250 revenue					
	-	country	(%)					
		operators						
Germany*	17	1	9,66					
France	12	-	8,22					
United Kingdom	15	3	5,79					
Netherlands	5	1	2,16					
Spain	5	1	1,69					
Switzerland	4	-	1,39					
Belgium	4	-	1,20					
Sweden	4	2	1,00					
Russia	4	4	0,87					
Italy	4	2	0,86					
Norway		1	0,49					
Portugal	2	-	0,48					
Finland	2	-	0,41					
Austria	2	-	0,33					
Denmark	2	-	0,33					
Croatia	1	-	0,14					
European Retailers	85	15	34,97					
Top 250 Global	250	82	100,00					
Retailers								
	Country Germany* France United Kingdom Netherlands Spain Switzerland Belgium Sweden Russia Italy Norway Portugal Finland Austria Denmark Croatia European Retailers Top 250 Global	CountryNumber of companiesGermany*17France12United Kingdom15Netherlands5Spain5Switzerland4Belgium4Sweden4Italy4Norway3Portugal2Finland2Austria2Denmark2Croatia1European Retailers85Top250Global250	CountryNumber of companiesNumber of single country operatorsGermany*171France12-United Kingdom153Netherlands51Spain51Switzerland4-Belgium42Russia44Italy42Norway31Portugal2-Finland2-Croatia1-European Retailers8515Top25082					

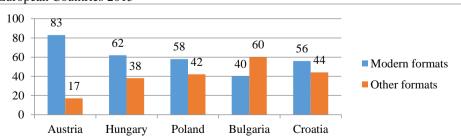
 Table 1. European Countries with the Largest Retailers 2015

Annotation: \* One company together with Belgium. Source: Global Powers of Retailing 2017, Deloitte, pp.17 – 22.

# 5.2. Forms of retail business units and online retail

Characteristics of the retail business units' structure in the FMCG sector for selected European countries are shown in graph 8. As the modern store formats in this graph are shown: hypermarkets, supermarkets, discount stores and cash and carry.

**Graph 8.** Value shares (in %) of store formats in FMCG – sector 2015 in selected European Countries 2015



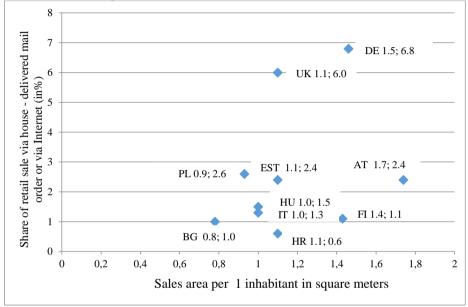
Source: Consumer Panels, Base: Tillroll or FMCG Tot al (depending on country), in: Schediwy, 2016, p. 12

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Graph 8 shows that the modern formats of retail business units in the FMCG sector in the transition countries are significantly less present. This is in line with the level of their economic development.

The development of online retail sales in the selected European countries can be seen from the data in the graph 9, showing the share of retail sales by mail and the Internet in the total retail trade turnover in the selected European countries in 2014.

**Graph 9.** Share of retail sale via mail order houses or via Internet in the retail trade\* of the selected European countries in 2014



Annotation: \* G-47 – retail trade, except motor and motorcycles. Sources: (a) *Einzelhandel Europa 2016.*, GfK Studie zu relevanten Einzelhandelsindikatoren für 2015 und Prognose für 2016.

(b) Annual detailed enterprise statistics for trade (NACE Rev. 2G) Eurostat, 2017.

It can be seen from the graph 9 that in the Republic of Croatia, retail sales by postal mail and the Internet accounted for only 0.6% of total retail turnover in 2014, although it could be much higher according to the indicators of sales equipment. However, taking into account online retail sales of foreign retail companies in the Republic of Croatia as well, a different result is obtained.

Graph 10 shows the percentages of individual customers (of the total number of customers) who have bought online and shares of online retail trade (domestic and foreign retail) in the total retail trade of selected European countries. It can be seen that the online purchase of Croatian customers from the retail companies from other countries was significant.



**Graph 10.** Last online purchase in the 12 month (2015) and online retail trade share in total retail trade (in %) in selected European Countries

Regarding this it can be assumed that there are still some unused opportunities for online retail in the Republic of Croatia. But given the relatively small market (by population and geographically), the data is not surprising.

#### 6. CONCLUSION

In considering the business logistics of retail companies, it is necessary to analyze the entire distributive trade, because large retail companies have also entered the wholesale trade business. By development of retail supply chains, trade logistics is becoming increasingly important because in such circumstances large retail companies manage economic flows in a broader, international level.

In recent developments, the importance of business logistics for retail companies is growing, not only due to the development of globalization and penetration of new technologies, but also due to the new consumer demands in terms of sustainability, healthy diet, older population supply, energy savings, unnecessary waste reduction, new consumer habits, etc.

In the last decade in the Republic of Croatia, retail trade (in terms of turnover and sales area growth) developed faster than the overall economy. In this way according to its share in the overall economy - it became increasingly important economic activity.

However, retail companies based in the Republic of Croatia (apart from one) did not sufficiently develop supply chains as drivers of economic development. This

Sources: (a) Internet purchases by individuals, Eurostat, 2017. (b) Onlinehandel: Das Europa der zwei Geschwindigkeiten, 2017.

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shows data on the smaller representation of modern forms of retail business units (retail formats) and on the shares of Croatian retail companies in online retail. Of course, opportunities to create regional supply chains (e.g. for fresh food) are still unused and in this direction should go further researches.

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# PRICE PROMOTIONS – IMPLICATIONS FOR LOGISTICS AND CONSUMER BEHAVIOUR

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#### Abstract

Forward buying is common business practice among retailers who purchase large quantities from their suppliers when product price is low. They keep those large quantities at their stock after the price promotion ends and continue to sell them at the regular price. But what about consumers? They use different ways for informing about products and their prices and although they are well informed about prices, for some of them contemporary lifestyle leaves little time available for consumer goods shopping. One would expect that smart consumers would wait for the lower prices and then purchase extra inventory, more than they need at the moment, in order to seize the opportunity of lower prices and avoid frequent shopping trips. This kind of consumer behaviour is also well known as the starting whip in the bullwhip effect in the supply chain. This paper aims to fill the gap in the literature of products stockpiling in households (at the consumer level). Indicative research was conducted among 305 households in order to find out to what extent and to which product categories consumers are prone to stockpiling. Certain attention was given to household's space constraints and the perception of extra inventory in the household as a good investment. Research has shown that most consumers are prone to buy products for future consumption, mostly due to rational behaviour and awareness of price promotion. Commonly stockpiled are non-perishable product categories and products that do not lead to higher consumption. Respondents who stockpile food categories mostly believe that higher household inventory of products lead to increased consumption. Unlike the household's space constraints, perception of extra inventory in the household as a good investment proves to be statistically significant for consumers in deciding on purchasing amount of products.

Key words: stockpiling, households, price promotions, stockpiling constraints

#### 1. INTRODUCTION

Although contemporary literature and business practice put consumers in the centre, due to the retail concentration process in the food and fast-moving consumer goods (FMCG) sector, retailers became the most powerful member in the supply chain. With the raise of their power, trade promotions became large cost for manufacturers, equally or even larger than usual advertising of their brand. Various costs resulted from activities encouraged by retailers which enabled them to charge manufacturers slotting allowances, to demand product variety, to include manufacturers in their promotion programs and to use price promotions for forward buying (Buzzell et al., 1990). Retailers use forward buying in order to seize the opportunity of manufacturer's deals and together with price fluctuations, forward buying has the key role in the bullwhip effect (Zotteri, 2013).

Consumers can also behave in a similar way and if they are forward-looking it can affect their purchase decisions (Ching & Osborne, 2015), which is in the same time limited by factors such as storage constraints, finance and others which also affect purchase amount. Price promotions are seen as a critical in the management of the fast-moving-consumer goods (Breiter & Huchzermeier, 2015) with special emphasize on their profitability for retailers and manufacturers, but also logistical issues such as demand forecasting, inventory management, out-of-stock situations and stockpiling in the consumers' households. American Marketing Association (2017) defines price promotion as "the advertising of a price for a product or service and usually, the price being promoted is a reduction from a previously established price and may take the form of a lower price, a coupon to be redeemed, or a rebate to be received". As one of the results of price promotions, household's products stockpiling can occur. Huchzermeier and Iver (2006) state consumer stockpiling behaviour as one of the four key factors, along with information sharing, variety effects and customer segmentation, that has to be taken into account in order to decrease the promotion forecast error in the supply chain. Furtherly, Pozzi (2013) emphasizes the role of technology and development of e-commerce which facilitates stockpiling because of ease of price comparison between retailers and absence of physical costs such as carrying large and heavy bags from the store.

However, apart from physical costs, buying large amounts of products requires certain storage space, especially for large and bulky products, and certain financial investment. Same as in companies, inventories in households are frozen capital, particularly if there are extra inventories for future use. This paper is focused on the implications that price promotion have on logistics and final consumer level. Therefore, following are research questions of the paper:

- Are consumers prone to buy products for future consumption? For which product categories?
- Do space constraints in household affect consumers to buy larger amounts of products during price promotions that will be used until next price promotion?
- Does perception of extra inventory in household as a good investment affect consumers to buy larger amounts of products during price promotions?

For this purpose, the survey questionnaire was conducted on the sample of 305 consumers, i.e. shoppers. It was examined whether respondents buy larger amounts

of products for future use, which product categories they buy in large amounts and what is their perception of the increased consumption due to extra inventory in household.

# 2. LITERATURE REVIEW

## 2.1. Supply chain pricing issues - implications for stockpiling

Pricing issues have been and still are one of the most tense areas in the relationship of retailers and their suppliers, especially when it comes to promotional pricing. Price promotions significantly challenge supply chain coordination and those fluctuations in prices are one of the key causes of bullwhip effect. Among other things, they lead to forward buying at retailer level and stockpiling at consumer level. Lack of coordination is mostly induced by different objectives of supply chain members and lack of information sharing (Chopra & Meindl, 2016). Therefore, when it comes to price promotions, bullwhip effect could be avoided by the timely or even real-time information sharing on price promotions' start, duration and expected effect. However, retailers often avoid sharing of those information in order to keep the information from their competition, i.e. other retailers. Breiter and Huchzermeier (2015) report that retailers and manufacturers in Germany agree on a yearly basis on wholesale prices and timing of price promotions, but not on regular retail or promotional prices, since it is prohibited by the law. The importance of those prices arises from the fact that retailers use products on promotional prices to attract as many as possible consumers in their stores and want those prices to be more attractive (lower) than competitions' prices. Furtherly, not any product can be equally tempting to consumers. Usually more attractive are famous brands or goods of well-known quality. On the other hand, manufacturers of such products don't want too low promotional prices because, among other reasons, it can lower their brand image among consumers. In the late 1980's, American retailers demonstrated their power in the supply chain and the importance of price promotions for them by announcing to their suppliers that "everything we buy from you will be at the lowest promotion price offered throughout our entire system", which led to a strong opposition from the suppliers and disruption of their relationship (Buzzell et al., 1990). One would expect that store flyers<sup>1</sup> affect positively stockpiling and additionally encourage it, but Gázquez-Abad & Martínez-López (2016) report that store flyers affect more brand switching than stockpiling. However, if the manufacturer managed to build strong brand with loyal consumers, brand switching should not present a large problem. Loyal consumers will stockpile their favourite branded products in their households for future consumption, while consumers who are not loval to one brand, but are more inclined to brand switching will not stockpile products in their households (Chan et al., 2004; Gázquez-Abad & Martínez-López, 2016). Some benefits of consumer

<sup>&</sup>lt;sup>1</sup> Store flyer is a "frequently distributed free printed matter, part of the mass communication marketing from the sender(s), with a minimum of four pages, immediately readable, targeted at private households or firms" (Schmidt & Bjerre, 2003 *cited in* Gázquez-Abad & Martínez-López, 2016)

stockpiling for manufactures are increased consumption, preventive brand switching and repeated purchases (Ailawadi et al., 2007). However, companies can have profit issues in long-term period if stockpiling is regular by loyal consumers (Gangwar et al., 2015), who would buy products at regular prices as well. Previously imposes other potential issues in retailer – manufacturer relationship, such as different goals in increase, both sales and consumption - of the one brand (manufacturer) or of the whole product category (retailer) (Chan et al., 2004) or the retailer's private label.

When retailers want their consumers to stockpile, e.g. during seasonal clearance, promotion at the point of sale such as additional displays is more effective than store flyers (Gázquez-Abad & Martínez-López, 2016). In nowadays dynamic pricing environment, strategic consumers wait to make a purchase at a specific price or the target time, but company can also benefit by keeping the consumers in the game, not to leave the market due to too high price, because they know that price will be lower and affordable at a certain moment (Cho et al., 2009). Benefit of product stockpiling in consumers' households can be alleviated reaction to out-of-stock situation in the store, whereby consumers will probably postpone or cancel the purchase (won't switch brands or go to other retailer's store) because of the existing inventory at home (Verhoef & Sloot, 2006).

#### 2.2. Logistics implications of pricing strategies

Since all consumers don't need and don't want to search the best prices in the market and stockpile products for the future consumption, for example organic food consumers (Brčić-Stipčević et al., 2011), this allows retailers to use higher prices strategies. High – low pricing strategy and price skimming are greatly represented among retailers given that consumers do make purchases regardless of the price level (Ching & Osborne, 2015). Because of the occasional and timely limited promotional prices in their offer, which are often the best prices in the market in the certain moment, these strategies have mostly logistics disadvantages. Most emphasized are (Levy & Weitz, 2012; Zentes et al., 2011; Huchzermeier & Iyer, 2006):

- purchase acceleration which usually lead to product stockpiling, especially of fast moving consumer goods (FMCG);
- more difficult retailers' planning of future demand and large forecast error;
- more difficult inventory management and high inventory costs;
- greater challenges for supply chain coordination which can lead to bullwhip effect.

There are also several logistics advantages. An opportunity to make a clearance of products with slow inventory turnover and increased consumption (Levy & Weitz, 2012) can lead to greater logistics efficiency by reducing average inventory level and better use of economies of scale when ordering and transporting because of sales increase induced by increased consumption. In addition to that, Hamister and Suresh (2008) show that dynamic pricing may also "lead to higher profitability and reduced demand variability when demand is serially correlated".

High-low pricing strategy resulted with the appearance of the consumer segment called *cherry pickers*, who catch the best offers in the market. They research, compare and buy only during special price promotions and their average consumer basket is

lower than others' consumers (Bell & Lattin, 1998; Popkowski Leszczyc et al., 2004; Fox & Hoch, 2005), imposing the conclusion that they don't buy large amounts and stockpile them, but do more frequent shopping trips.

Furtherly, significant part of FMCG products are not type of the products whose consumption will or can increase because of the stockpiled inventory in the household. Shapiro (2016) states that this fact prompted development of Every Day Low Prices (EDLP) retail strategy. Due to less price and demand fluctuations, these EDLP retailers base their price advantage largely on logistics efficiency, mostly on inventory management and transport (Levy & Weitz, 2012), but in-store (e.g. shelf replenishment by using retail ready packaging) logistics as well. Therefore, Bolton and co-authors (2006) state that retailers should focus their price fluctuations on the product categories that stimulate demand increase (consumption increase) and not only stockpiling.

#### 2.3. Stockpiling, product categories and constraints

Consumer stockpiling raises logistical issues of price promotions. Short term price promotions affect what amount will consumers purchase and lately consume. However, Breiter and Huchzermeier (2015) showed that demand during price promotion is significantly determined by household inventory levels. This confirms the state of Beasley (1998) who reported that inventory level has negative effect to the incidence of stockpiling, while deal proneness and depth of a price cut have a positive effect. When consumers buy larger amounts during price promotions, Bell et al. (2002) distinguish pure stockpiling (there is no increased consumption and next purchase will be later than usual) and flexible consumption (increased consumption because of the larger inventory in the household and next purchase will be less later than in case of pure stockpiling). Furtherly, increased consumption can be induced by the household's income or by using stockpiled products as a substitute for other similar products or categories (Chan et al., 2004). Flexible consumption causes lower level of bullwhip effect than pure stockpiling.

Flexible consumption is variously present among different product categories. While some categories are subject to increased consumption, some categories' consumption is not affected by large inventory in the households. Price promotions are more often and deeper in the categories which are subject to increased consumption (Bell et al, 2002) and also are more often a subject to bullwhip effect. Similarly, Shapiro (2016) sees expandability or growth potential within the product category as two-parted - expandable consumption (potential increase in consumption - using more of the same product if you have it in household) and expandable purchasing (potential increase in purchasing amount because there are no or are reduced constraints for inventory holding). An important role have the characteristics of the products within the category. Pure stockpiling usually occurs among categories with limited expandable consumption, but with expandable purchasing (durable goods with longer shelf life). Gangwar et al. (2014) state that toilet tissues and coffee have relatively constant consumption and their stockpiling would probably lead to longer time before next purchase. On the other hand, flexible consumption usually occurs among categories with both expandable consumption and expandable purchasing,

such as snacks or drinks. But, short shelf-life of large number of consumer packed products can have constraint effect on the purchasing.

Products or categories with higher absolute prices or of larger size volume can have other constraints for expandable purchasing and consequently expandable consumption. Although budget constraint is seen as one of the most common constraints and as a barrier between attitudes and behaviour of the consumer in the contemporary environment (Uncles, 2006), Satomura et al. (2011) emphasize the role of multiple constraints, including space constraints induced by weight or quantity of the products. They find it unlikely that consumers will hire additional storage space to hold their household inventory of large volume products. Bell and Hilber (2006) showed that household storage constraints are statistically and quantitatively significant for purchasing quantity of products which are spatially demanding and require certain storage space, like detergents or paper towels, while smaller and less spatially demanding products like pills are not affected by storage constraints in household and it does not affect stockpiling behaviour. Pires and Salvo (2015) found that budget or cash constraints are economically significant for the low-income households and less significant for high-income households what is in accordance with the fact that high-income households more often buy large packaging than lowincome households. Large packaging have higher financial and storage requirements, but usually offer better regular unit price. However, price promotions of smaller packaging can achieve even better unit price. Nevertheless, Orhun and Palazzolo (2016) state that even on price promotions low-income households do not succeed to take the advantage of lower price and stockpile products for future use because of the liquidity constraints.

Another perspective on stockpiling constraints gave Huchzermeier and Iyer (2006) who researched non-loyal consumer segment of canned tomato soup who are more prone to stockpiling than loyal consumer segment. They state holding cost, storage space and liquidity constraint as important factors that those consumers take into account when deciding on purchasing amount during price promotion.

#### 3. RESEARCH METHODOLOGY

For the purpose of this indicative research, test method and a highly structured questionnaire as a test instrument were used. The research was conducted in February 2017 on a convenient sample of 305 respondents in two counties of eastern Croatia. Respondents were persons who are involved in shopping for their household, but not necessarily primary shoppers. They were questioned for their purchases in FMCG retailers, in whose stores prevail food products and other non-food products for everyday consumption. Therefore their characteristic product categories were examined like chocolates and personal hygiene products, while categories like furniture or seasonal products were not examined. Respondents could participate in research through online questionnaire created in provided Google Forms template or paper questionnaire. The questionnaire contained multiple choice questions and 5-point Likert scale measures. The following table 1 shows sample description.

	I — -	n	%
Gender	Total	305	100
	Male	66	21.6
	Female	239	78.4
Age	Total	305	100
	18-29	51	16.7
	29-39	75	24.6
	39-49	67	22.0
	49-59	79	25.9
	60 and more	33	10.8
Education	Total	302	100
	Primary school	9	3.0
	High school	116	38.4
	Faculty and higher	177	58.6
Place of residence	Total	300	100
	Town	227	74.4
	Smaller place	73	23.9
Monthly income of all	Total	302	100
members in household	Less than 5.000,00 HRK		22.6
	5,000.00 – 10,999.00 HRK	69 170	55.7
	11,000.00– 16,999.00 HRK	51	16.7
	Equal to or greater than 17.000,00 HRK	12	3.9
Employment status	Total	305	100
Employment status	Employed	252	82.6
	Unemployed	252	8.2
	Student	9	3.0
	Retired	19	6.2
Members of household	Total	304	100
Weinbers of nousehold	1	42	13.8
	2	75	24.6
	3	83	27.2
	4	68	22.3
	5	36	11.8
Children in household	Total	293	11.0
under 15 years old		171	58.4
under 15 years old	1	67	22.9
	2	42	14.3
	3		
		12	4.1
	4 and more	1	0.3
Housing	Total	305	100
	Apartment	147	48.2
	House	158	51.8
The size of the living space	Total	305	100
in m <sup>2</sup>	0-49.99	36	11.8
	50 - 89.99	117	38.4
	Equal to or greater than 90	152	49.8

# Table 1. Sample description

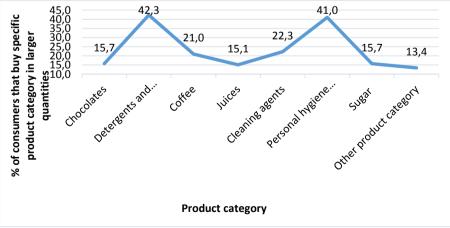
Source: authors' work

Survey questions were created based on Gangwar et al. (2014), Bell and Hilber (2006), but also authors' own contribution. Next chapter shows research results.

## 4. RESEARCH RESULTS

In order to find out whether respondents buy larger amounts of products, i.e. stockpile, they weren't directly asked whether they buy larger amounts of products, but to mark certain product categories that they buy in larger amounts. Among product categories, an option that they don't buy larger amounts of products was also offered. Most of the respondents marked one or more categories. While 70% of respondents buy in larger amounts, 30% of them marked that they don't buy any product category in larger amounts. These 30% of respondents are mostly two-member households (34.4%), but with no children (64.4%), mostly highly educated (65.6%), but with middle monthly household income (57.8%). It is interesting that there is no difference whether they live in the apartment (50%) or house (50%) and that majority of them have large living space, more than 90 m<sup>2</sup> (44.74%). Those who are prone to stockpiling of at least one product category are mostly three-member households (30%), but also mostly without children (54.6%). Most of them are highly educated (55.9%) and with middle monthly household income (55.7%). They live mostly in house (52.3%) and have living space larger than 90 m<sup>2</sup> (51.9%).

Specific product categories which are bought in larger amounts are shown in the Graph 1. Majority of respondents buy washing detergents and softeners (42.3%) and personal hygiene products (41%), such as shampoos or shower gel, followed by cleaning agents (22.3%). Food products like juices (15.1%), sugar (15.7%) or coffee (21%) are less often bought in larger amounts for future consumption. This could be logically described with product characteristic of longer expiry date as one of the most important physical characteristic when deciding in which product category on price promotion consumer will do stockpiling.



Graph 1. Buying larger amounts of various product categories

Source: authors' work

For different product categories, consumers look for low or even best prices in the market due to the different reasons. Graph 2 shows those reasons of respondents that buy certain product categories in larger amounts. Scores for all product categories are not equal to 100 % due to decimal rounding.

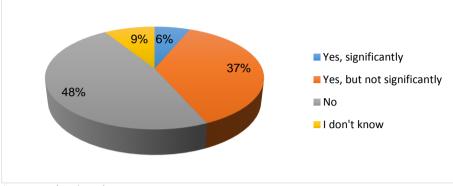


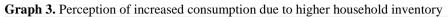
Graph 2. Reasons for looking for low prices of various product categories

Source: authors' work

Financial reasons are most represented among two food categories – sugar (21%) and coffee (17%). Rational behaviour is most present among non-perishable categories, which are also quite financially demanding – cleaning agents (53%) and detergents and softeners for washing (51%). For the category of juices (50%) respondents mostly calculate because of the future regular price promotions to which they are accustomed. The price isn't deciding factor mostly for chocolate (10%), coffee (8%) and personal hygiene (8%).

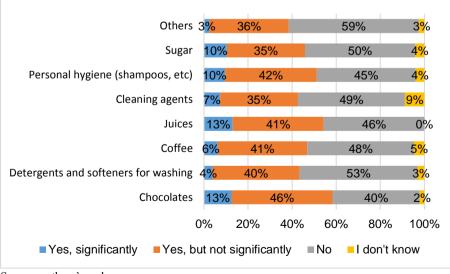
Graph 3 shows the perception of respondents whether higher household inventory of products lead to increased consumption. Majority of respondents (48%) believe that higher household inventory doesn't encourage their increased consumption. However, significant proportion of respondents (43%) think that they increase their consumption, but only 6% of them significantly.





Source: authors' work

Furtherly, graph 4 shows the perception of increased consumption by product category of the respondents who pleaded that they buy certain product category in larger amounts. As for the graph 2, due to decimal rounding scores for all product categories are not equal to 100 %. The largest perception of increased consumption is in categories of chocolates (59%) and juices (54%). It is interesting that a large percentage of respondents find increased consumption within personal hygiene category (52%). On the other hand, the largest percentage of respondents perceive no increased consumption in the category of detergents and softeners for washing (53%), sugar (50%), cleaning agents (49%) and coffee (48%).



Graph 4. Perception of increased consumption by product category

Source: authors' work

For the purpose of this study and stockpiling constraints research, authors developed two three-item scales, for *space constraints* in the household for buying larger amounts of products and for perception of extra inventory in the household as a *good investment* (budget constraint). Scales consisted of three statements measured in five-point Likert scales. Table 2. presents the complete item scale.

<b>TADIC 2.</b> Item scale						
Space	The amount of product I buy on the price promotion is limited					
constraints	to the available space in the household for product storage.					
	The amount of product I buy on the price promotion is limited					
	by the size of the product and the space it occupies.					
	If I had more space in the household, I would buy larger					
	amounts of products on the price promotion.					
Good	Larger household inventories are a good investment if bought					
investment	on a price promotion.					
	I rather buy higher amounts at once on price promotion.					
	It is better to keep larger amounts in the household than to waste					
	time and money on frequent shopping.					

Table 2.	Item scale
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Source: authors' work

Both created constructs have satisfying Cronbach's Alpha since 0.7 is considered to be an acceptable reliability coefficient<sup>2</sup>. Space constraints scale has 0.798 and extra inventory as a good investment 0.722 (Table 3).

**Table 3.** Reliability analysis of the constructs and descriptive statistics

Measurement scale	Cronbach's Alpha	N of Items	Mean	Variance	Standard deviation
Space constraints	.798	3	8.04	13.746	3.708
Good investment	.722	3	9.57	11.618	3.408
Common and home' mode					1

Source: authors' work

Table 4. shows the proportion of the variance in the dependent variable that is explained by this model. R Square of .267 means that this model explains 26.7 % of the variance in buying larger amounts of products during price promotion that will be used until next price promotion (dependent variable).

<sup>&</sup>lt;sup>2</sup> Nunnaly, J. (1978). Psychometric theory. New York: McGraw-Hill *cited in* Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. Journal of extension, 37(2), 1-5. Available at: <u>https://www.joe.org/joe/1999april/tt3.php/journal-current-issue.php</u> [accessed: March, 5 2017]

## Table 4. Model summary

Model Summary <sup>b</sup>							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate			
1	.517ª	.267	.262	1.251			

a. Predictors: (Constant), Space\_constraint, Good\_investment

b. Dependent Variable: I buy larger amounts of products that will be used until next price promotion

Source: authors' work

The ANOVA results are shown in the table 5. Considering that Sig = .000, i.e. p<0005, this indicates the statistical significance of the result in the Model summary table.

## Table 5. ANOVA

**ANOVA**<sup>a</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	167.574	2	83.787	53.521	.000 <sup>b</sup>
Residual	460.259	294	1.566		
Total	627.833	296			

a. Dependent Variable: I buy larger amounts of products that will be used until next price promotion.

b. Predictors: (Constant), Space\_constraints, Good\_investment Source: authors' work

The following table 6 reveals which variable contribute to the prediction of the dependent variable. The Significance column indicates that space constraints in household is not statistically significant variable (p=0.350).

#### Table 6. Regression coefficient

**Coefficients**<sup>a</sup>

	Unstandardized Coefficients		Standardized Coefficients		
Model	В	Std. Error	Beta	t	Sig.
1 (Constant)	.753	.251		2.996	.003
Good_investment	.223	.022	.522	10.323	.000
Space_constraints	019	.020	047	937	.350

a. Dependent Variable: I buy larger amounts of products that will be used until next price promotion Source: authors' work On the other hand, perception of large amounts of products in household as a good investment has a significant positive influence on buying larger amounts of products during price promotions that will be used until next price promotion (p=0.000;  $\beta$ =0.522).

## 5. CONCLUSION

Encouraged by contemporary lifestyle, financial situation and retailers' offers, consumers are more prone to save the money or to save the time. Household's products stockpiling can save their time by reducing the frequency of necessary shopping trips, but stockpiling during price promotions can save them both, time and money. However, this kind of behaviour affects supply chain activities and efficiency.

More affected by stockpiling are retailers and members of their supply chain who use high-low pricing strategy and have occasionally deep price promotions, unlike those retailers who use EDLP strategy. They have significant logistical issues due to unstable and irregular demand incurred by short-term price promotions. The occasional price promotion became quite regular over a certain period of time that consumers got accustomed to them and include them into account of what, when and how much to buy. On the other side, consumers take into account their constraints as well, which usually manifest in the form of budget or liquidity constraints, household's space constraints, time constraints, etc.

Research has shown that most consumers are prone to buy products for future consumption, i.e. to stockpiling (70%) of various product categories. The most common are non-perishable product categories and also products that do not lead to higher consumption - washing detergents and softeners, personal hygiene products and cleaning agents, unlike chocolates or juices that could lead. Furtherly, detergents and softeners are bulky and highly space demanding products and despite that are very often bought in large amounts, most likely due to large money saving during price promotions. Previously confirms the results obtained using regression analysis which suggest that space constraints is not statistically significant variable. However, budget and liquidity constraints, which are turned in this paper as perception of extra inventory in the household as a good investment, proved to be significant in deciding on purchasing amount of products that will be used until next price promotion. Further research should be done in other countries with different disposable income (or/and life standard), and available living space then in Croatia to validate these conclusions.

Research also showed different reasons for looking for low prices of product categories that are bought in larger amounts, but in all product categories prevail rational behaviour and awareness of price promotion.

Results also show that significant proportion of respondents (43%) believe that higher household inventory of products lead to increased consumption which is most present among those respondents who buy food categories in larger amounts – chocolates and juices. Increased consumption is the least present for non-perishable categories – cleaning agents and detergents and softeners.

Findings in this study once again imply retailers that price promotions could lead to logistical challenges because of the large number of consumers who are prone to stockpiling. They should take consumer stockpiling behaviour into account when forecasting demand. Also, they should try to focus even more on product categories with potential for increased consumption as those who would attract consumers in the store and minimize deep price promotions of product categories like detergents, softeners and personal hygiene products. They need to keep in mind that consumers' household space constraints or the product size are less likely to negatively affect the stockpiling if consumers find their offer as a good investment, what means to stockpile and leave the market for certain period of time.

Research limitations arise from geographically restricted area from which the included respondents come, own assessment of the respondents which may differ from the actual behaviour and few independent variables included in the regression model.

Future research should give special attention to the problem of food waste in the supply chains caused by the consumer products stockpiling in the households. When it comes to regression model used in this paper, future research should include more independent variables, e.g. time constraints, in order to identify more statistically significant variables and achieve higher explanation of the variance within the model. Including larger geographic area and representative sample in the survey would also be preferable. However, if possible, panel data would give even better insight in consumer stockpiling with more accurate information.

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# VI. TECHNOLOGY IN LOGISTICS

# CONCEPTUAL CRM APPLICATION DATABASE MODEL IN THE FUNCTION OF PHYSICAL PRODUCTS DISTRIBUTION FOR KNOWN CUSTOMER

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#### Abstract

The second half of the twentieth century was marked by significant social changes caused by extremely fast technology advancement, particularly informationcommunication technology. Besides changes in the way of doing business they have also brought changes in human society in general. Together with mass media and educational systems, information-communication technology (ICT) has influenced the growth of the overall information awareness, knowledge and human selfconsciousness. A modern human being is now acting as an individual with clearly expressed needs and attitudes to products and consumption. On the other hand, the human i. e. customer permanently encourages modern producers, i.e. suppliers, to change the relationship. This relationship change is known and is theoretically articulated through relationship marketing concept i. e. as customer relationship management. The outlined concepts strive to maintain communication with consumer as individual in order to achieve optimal satisfaction of individual customers' needs. Modern industry 4.0 is already able to produce individualised products for known customers with the use of robotic and programmable machines and CRM applications ensure by the means of communication, that is presale, sale and post-sale activities, the optimal individualized fulfilment of customer needs. The future certainly brings transition from mass production for unknown customer to production for known customer. This will also influence the change of product distribution in the way of moving from mass distribution to individualized distribution. This kind of change demands the adequate adjustment of CRM applications which must provide producer (supplier) and customer with key information about distribution as post sale activity. In that way it is necessary to observe the data coverage and develop an optimal database model in the function of achieving optimal satisfaction of individual customers' needs in the product distribution phase. From that standpoint it is

meaningful to talk not only about product distribution, but also about information distribution, and to observe distribution as information phenomenon.

Key words: databases, relationship marketing, CRM, product distribution, information-communication technology.

#### 1. INTRODUCTION

The transition to the new 21. century symbolically presents the transition of modern industrial society to the new information era. This transition actually started in the second half of the twentieth century, and its initiator is contemporary information-communication technology. However, information-communication technology is just one of the technologies which induced fundamental changes in society. Namely, from the beginning of the last century, especially after the World War II, the technological development has enabled mass production which has brought to significant changes in the market relations. While in the part of industrial era, in the period of products shortage, the producer i.e. supplier was in the more favorable market position, in the developed industrial era the appearance of product surpluses on the market has brought the consumer to a better market position. This better market position of consumer asked for an appropriate market reactions of the supplier, in the way that in the first step the producers i.e. the suppliers tried to solve this situation with the sales promotion, that is with activities aimed at customers in the way to try to persuade the customers to buy products without knowing his actual needs. The effects of these efforts were usually short term since the consumer i.e. the buyer has learned to be careful and distrustful through the interaction with sellers, and it become harder to "persuade" the buyer to buy the product he doesn't need. When the selling concept started to show its weakness, the solution was found in fairly and more acceptable for the customers, marketing concept. The main idea of marketing is to put the consumer instead of the buyer in the center of the interest, that is the needs of the customer, and instead of an intuitive approach to deciding about the product assortment, this problem is approached rationally in a way that explores the market and defines the needs of consumers, based on the knowledge of consumer needs to define a production program. This marketing approach proved to be successful, leading to the development and "perfecting" of marketing, and marketing has in principle become a fundamental business philosophy. The appearance of marketing is connected to the middle of last century.

It is important to bear in mind that technology development and society development are intertwined with each other and in the same time the technological development is pushing the social development and social development encourages technological development. Social development is manifested, among other things, in the growth of knowledge both of individuals and society as a whole, and the growth of knowledge affects the growth of self-awareness and the growth of population needs. The higher the level of knowledge and self-consciousness of an individual, the more his aspiration to individuality increases. The growth of the individuals' needs has affected the evolutionary market processes, which manifested itself in an increase in the level of market segmentation. The level of market segmentation has encouraged the evolutionary processes in marketing, so while marketing in the middle of last century followed and produced mass production, in the next period, in the 1970s marketing segmented the market and produced a growth in product assortments in line with market segments. In the eighties of the last century the focus of the marketing was on even more narrow market segments, i.e. niches, which leads to further grow of product differentiation and to further grow in both volume of production and product range. The plexus of industrial potential, the growth of awareness and knowledge, and through this, individual consumers' needs in the nineties of the last century, resulted in such a subtle segmentation of the market that segmentation became atomistic and reached the level of one on one relationship between supplier and consumer. In order to reach such fine segmentation it was necessary to develop or encourage the development of the new approaches in both the industry and marketing. The industry started to build systems which are capable to produce small or individual products for a well-known, personalized consumer within the framework of a new version of industrial production that carries the label industry 4.0. Marketing, on the other hand, has evolved into a new developmental version that carries the name of relationship marketing, whose motivation is the establishment and development of long-term partnerships with consumers. In order to keep consumers and to build longterm partnerships, relationship marketing puts the emphasis on permanent and continuous communication with consumers, all in order to create products and provide services that will optimally meet the needs of consumers. Given the volume and turbulence of modern market processes, such communication is impossible today without the use of information-communication technology or marketing databases as data hubs, i.e. information and knowledge about consumers' needs and behavior. The concept that was based on a systematic approach to the realization of relationship marketing primarily using the information-communication technology carries the name Customer Relationship Marketing, i.e. CRM. Consumer relations are managed in the framework of pre-sales, sales and post-sales activities to achieve the optimal satisfaction of consumers' needs and ensure consumer satisfaction. It is assumed that a satisfied consumer will be a loyal consumer, because in today's market conditions, it is increasingly difficult to win a new consumer, so business entities are more likely to form a barrier around their consumers to prevent competition in their takeover. Often with the individualization of products, manufacturers i.e. suppliers increasingly use services as means of creating additional value or barriers that will prevent consumers from leaving. One of the additional services that in that sense plays a significant role in creating a barrier around consumers, is an integral part of marketing i.e. marketing mix, is product distribution. It should be borne in mind that small-scale and individual production for the well-known buyer, i.e. consumer, radically changes the approach to the design, implementation and follow-up of product distribution processes. It is precisely the problem of distributing the product to a known consumer in the new information age, which is an integral part of the small-scale or individualized production for the well-known consumer, in the focus of the conducted research which the results are presented with this paper.

In addition to all the above, it is worth pointing out other dimensions brought by the new information age, which ultimately have repercussions for changes in the Conceptual CRM application database model in the function of physical products distribution for known.. Branimir Dukić, Sanja Dugandžić, Stojanka Dukić

principles of product distribution. First of all, changes in distribution will affect the digitization of existing physical products as well as the emergence and development of new digital products resulting in a rise in the share of digital products in the total volume of products on the market. Therefore, a significant change will occur in changing the focus of society from physical to virtual distribution. One of the major factors of change is the addition of intelligence to physical products in the form of nano-computers, which will be reflected not only in the evolution of the concept of intelligent consumer electronics, or in the broader sense of the Internet of Things (IoT), but also on the principles of the product distribution in their lifetime, but also after their lifetime when it is time to dispose and recycle them. In this sense, the significance of automation and digitization of a part of product distribution will grow, i.e. the emergence and development of intelligent distribution. Furthermore, a tremendous impact on distribution will also be the growth of production capacities that produce physical products with the help of digitized knowledge, i.e. with the help of machines controlled by the artificial knowledge. Such products instead of large storage or distribution centers and large transport capacities will require mobile flexible transport systems that will ensure just-in-time product distribution from the manufacturer to the consumer. Ultimately, the important role for distribution and its further evolution certainly has the expected increase of the share of electronic business, especially electronic commerce in the total mass of business, i.e. trading in the new information age. All of this implies that the distribution we know of today will not be able to meet the needs of the industry, i.e. the society of the modern information age, so science faces the task of finding new solutions in terms of distribution evolution where digitization of data flows within the distribution framework will not be sufficient in terms of satisfying the needs of transformed way of action both in production and society as a whole, but the distribution will seek the fundamental changes that will need to be scientifically explored and modeled. The conducted research was going in the above described direction.

#### 2. RESEARCH METHODOLOGY

Particularly since the Second World War, human society is in the period of intensive technological development, and this technological development from the roots changes the principles of functioning of the entire society. For the development of modern industrial society and its transition to the new era, information and communication technology is particularly important, so it is not surprising that the new era is often referred to by this technology - information age. Evolutionary technological processes have a significant influence on the changes in society so that with the growth of the technological potential of the society the human needs have also grown. One of the directions in which modern society is developing is the significant growth of knowledge and self-consciousness of contemporary people, which leads to an increasing need for individualized and personalized products. Principally, the industry 4.0 has the ability to respond to these challenges in terms of production, and relationship marketing, i.e. CRM as its application generally allows the discovery and meeting of individual consumer needs. However, since the concept

is set to its realization, it is often a long way to solve a whole set of specific problems. One of such problems is a problem of optimal distribution of individualized and personalized products produced according to needs of known customers and with use of the possibilites provided by the industry 4.0. Given that this is a complex problem that basically changes the distribution principles that existed since the mass production, it can be seen from several perspectives, or through more problems. One of the problems is the way of organizing the data related to product distribution within the CRM system, which reffer to the product distribution to known customer. In relation to this, it is possible to set the following hypothesis:

It is possible to define a database model of CRM application which allows the distribution for known customer.

In relation to the outlined hypothesis, the defined research goals are as follows:

1. Overview the term of relationship marketing and its referrence to the concept of customer relationship management.

2. Overview the evolutive processes in society and how they reflect on the modern industrial production.

3. Overview how the changes in the modern industry reflect on the modern distribution.

4. Improve the existing CRM systems, i.e. their data base with the principal modelling of the database wich allows the distribution of individualized products for known customer.

Several scientific methods have been used for this research and among them significant meaning have deductive method, abstraction method, classification method, historical method, system analysis method, analogy method, specialization method, aggregation method, generalization method, composition method, descriptive modelling method, along with some other methods. The results of the conducted research are based on secondary and tertiary data sources, although the presented research findings are a part of a wider primary research which studies the problem of relationship marketing interaction, i.e. customer relationship management with development trends in industry, therefore the results of this research can be seen as the results of primary research not covered in this paper. Especially this applies to the defined final database model in the function of distribution of individualized products for known customer. Consequently, this work is the result of continuous research efforts by authors aimed at learning the changes brought about by the new information age or era of knowledge.

#### **3. RESULTS OF RESEARCH**

Since it was developed, in the middle of the last century, marketing has gone through several stages of development. The evolutive processes in marketing are conected to the depth of the market segmentation, so one can talk about the evolution of marketing from mass marketing, segmented marketing, niche marketing, and micro marketing, or marketing 1:1, which evolved into relationships marketing at the end of the last century. (Meler & Dukić, 2007, p. 82) According to Kotler: "Relationships and NetworksTransaction marketing is part of a larger idea called relationship

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marketing. Relationship marketing aims to build long-term mutually satisfying relations with key parties - customers, suppliers, distributors - in order to earn and retain their long-term preference and business." (Kotler, 2002, p. 7) The same author continues: "Effective marketers accomplish this by promising and delivering highquality products and services at fair prices to the other parties over time. Relationship marketing builds strong economic, technical, and social ties among the parties. It cuts down on transaction costs and time. In the most successful cases, transactions move from being negotiated each time to being a matter of routine. The ultimate outcome of relationship marketing is the building of a unique company asset called a marketing network. A marketing network consists of the company and its supporting stakeholders (customers, employees, suppliers, distributors, university scientists, and others) with whom it has built mutually profitable business relationships. Increasingly, competition is not between companies but rather between marketingnetworks, with the profits going to the company that has the better network." (Kotler, 2002, p. 7) From the above outlined it could be concluded that relationship marketing tranforms the essence of the marketing raltions and moves them from the sphere of hostilitiy among consumer and producer to the sphere of partnership wich ensures mutual satisfaction, as well as the satisfaction of all factors involved in the process of creating and exchanging products, or participating in the marketing network. Regarding relationship marketing, the synergistic activity of consumers and small producers, Harbor states: "Relationship marketing is a sales approach focusing on building a long-term relationship that benefits both the customer and the business. Some of the techniques businesses use in relationship marketing include providing consistently excellent customer service, getting to know the individual and anticipating their future needs, and offering discounts and special perks through loyalty programs for repeat customers. The rise of the internet gives small businesses ample opportunity to build relationships and engage with customers by inviting them to visit their websites and comment on blogs, as well as interact on social media sites such as Facebook, Twitter, Pinterest, YouTube and LinkedIn." (Harbour, n.d.)

The instrument relationship marketing uses to develop long-term relationship between consumers and producers is the concept of customer relationship marketing. The following can be explained in a simplified way for the concept of consumer relationship management: "CRM is the acronym for customer relationship management, a phrase describing web-based computer systems or software that helps businesses organize and provide marketing, sales and customer service assistance. Data collected includes information about customers' purchasing history, demographics, details of purchases and returns, and anything that will help salespeople assist the customer in future interactions. Much of this data must be entered by the sales team. CRM systems are also mined to identify new sales leads and potential new product or service areas." (Harbour, n.d.) Unlike this general understanding, CRM can also be understood significantly expanded: "Customer relationship management (CRM) is a term that refers to practices, strategies and technologies that companies use to manage and analyze customer interactions and data throughout the customer lifecycle, with the goal of improving business relationships with customers, assisting in customer retention and driving sales growth. CRM systems are designed to compile information on customers across different channels -- or points of contact between the customer and the company -- which could include the company's website, telephone, live chat, direct mail, marketing materials and social media. CRM systems can also give customer-facing staff detailed information on customers' personal information, purchase history, buying preferences and concerns." (Rouse, 2014) If it comes to CRM as application, for such software solution could be stated the following: "CRM software consolidates customer information and documents into a single CRM database so business users can more easily access and manage it. The other main functions of this software include recording various customer interactions (over email, phone calls, social media or other channels, depending on system capabilities), automating various workflow processes such as tasks, calendars and alerts, and giving managers the ability to track performance and productivity based on information logged within the system." (Rouse, 2014) Usually CRM application contains the following components:

- Marketing automation: CRM tools with marketing automation capabilities can automate repetitive tasks to enhance marketing efforts to customers at different points in the lifecycle. For example, as sales prospects come into the system, the system might automatically send them marketing materials, typically via email or social media, with the goal of turning a sales lead into a full-fledged customer.
- Sales force automation: Also known as sales force management, sales force automation is meant to prevent duplicate efforts between a salesperson and a customer. A CRM system can help achieve this by automatically tracking all contact and follow-ups between both sides.
- Contact center automation: Designed to reduce tedious aspects of a contact center agent's job, contact center automation might include pre-recorded audio that assists in customer problem-solving and information dissemination. Various software tools that integrate with the agent's desktop tools can handle customer requests in order to cut down the time of calls and simplify customer service processes.
- Geolocation technology, or location-based services: Some CRM systems include technology that can create geographic marketing campaigns based on customers' physical locations, sometimes integrating with popular location-based GPS apps. Geolocation technology can also be used as a networking or contact management tool in order to find sales prospects based on location. (Rouse, 2014)

CRM system is structurally defined on Figure 1.

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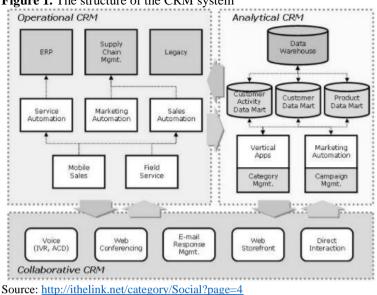


Figure 1. The structure of the CRM system

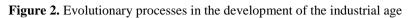
As it is shown in Figure 1., as a part of the back office, within the operational CRM, a supply chain management segment plays a significant role. The reason for this should be sought in the fact that is emphasized through the relationship marketing definitions, namely that relationship marketing tends to build marketing strategic alliances or marketing networks that connect to the value chain of consumers and all those involved in product creation. CRM as applicative element in relationship marketing in it structure, as it is shown in Figure 1., seeks to manage the marketing network. Collaborative CRM ensures interaction with customers through the customer touch point, while operational CRM supports collaborative CRM and ensures the functioning of the strategic alliance. The function of analytic CRM is to ensure the information base for the maintenance of the marketing network, i.e. to provide management with key information necessary to marketing oriented management of the business. Accordingly, the supply chain management, aims to ensure the operation of the marketing network and to open the way for successful problem solving of the distribution as one of the key marketing mix elements. The CRM system is based on principles and is also in the function of relationship marketing.

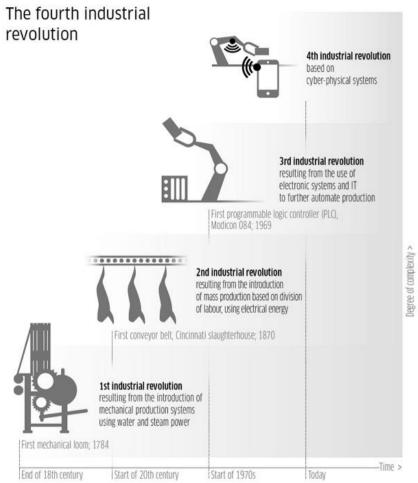
Otherwise, the relationship between relationship marketing and CRM could trivially be seen in the following way: "While relationship marketing is a sales and marketing concept, CRM refers to the tools used to carry out the concept. Relationship marketing is implemented as a strategy and includes activities such as identifying long-term sales and retention goals, public relations, marketing and advertising campaigns. CRM includes the operational tasks that support the relationship marketing strategy. Acitivities may include gathering data about the customers, then organizing and analyzing it to create target customer profiles. CRM data is also effective in finding opportunities to create special offers to reward long-time customers for their loyalty, further building the relationship. (...) Relationship

marketing seeks to increase sales by building trust and engaging customers. Using a CRM system effectively allows a salesperson to quickly and consistently deliver what customers are looking for with each and every interaction, because their preferences and buying history are recorded. The system benefits the customers, because they see the business "knows" them. CRM systems coordinate, automate and deliver online and offline advertising and marketing activities that help build the long-term customer relationships that are crucial to а successful relationship marketing strategy."(Harbour, n.d.)

As it is already mentioned, the marketing is the result of the evolutionary processes which were happening during the industrial age, and these processes have also influenced the changes in marketing. Concerning the emergence and evolutionary processes in the industrial age, and the transition of industrialization in the information age, Marr states: "First came steam and the first machines that mechanized some of the work our ancestors did. Next was electricity, the assembly line and the birth of mass production. The third era of industry came about with the advent of computers and the beginnings of automation, when robots and machines began to replace human workers on those assembly lines. And now we enter Industry 4.0, in which computers and automation will come together in an entirely new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can learn and control the robotics with very little input from human operators. Industry 4.0 introduces what has been called the "smart factory," in which cyber-physical systems monitor the physical processes of the factory and make decentralized decisions. The physical systems become Internet of Things, communicating and cooperating both with each other and with humans in real time via the wireless web (Marr, 2016). Evolutionary processes in the development of the industrial age are shown in Figure 2.

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Source: <u>https://www.kaercher.com/int/inside-kaercher/newsroom/kaercher-stories/industry-4-</u>0.html

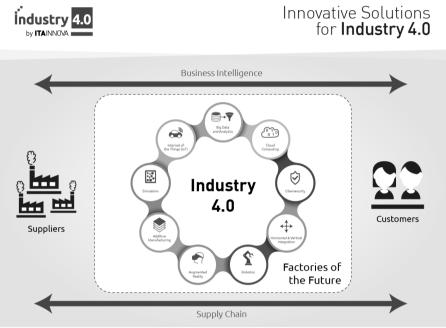
In order to state that a system of business entity operates according to the concpet of the industry 4.0, the system must include:

- Interoperability machines, devices, sensors and people that connect and communicate with one another.
- Information transparency the systems create a virtual copy of the physical world through sensor data in order to contextualize information.
- Technical assistance both the ability of the systems to support humans in making decisions and solving problems and the ability to assist humans with tasks that are too difficult or unsafe for humans.

• Decentralized decision-making - the ability of cyber-physical systems to make simple decisions on their own and become as autonomous as possible. (Marr, 2016)

The shema of the industry 4.0 is shown in Figure 3.

Figure 3. The shema of the industry 4.0 concept



Source: La importancia de la Supply Chain en la Industria 4.0 ITAINNOVA Instituto Tecnológico de Aragón

http://www.itainnova.es/blogs/soluciones-innovadoras-en-logistica/la-importancia-de-lasupply-chain-en-la-industria-4-0/

As Figure 3. shows, the one of the important factors of the successful application of the industry 4.0 concept, i.e. the application of relationship marketing on its fundamental level, is the optimal functioning of the supply chain. However, the supply chain management needs to evolve according to evolutionary processes that industry 4.0 brings. In this sense it is important to acknowledge the fact that supply chain management in the age of mass, or segmented marketing if a lot different than the supply chain management in the age of relationship management which works in the interaction with industry 4.0, i.e. with marketing that focuses on the one-on-one relationship between the supplier and consumer. This doesn't mean that in the relationship marketing age, i.e. the new information age there won't be products that will be massively produced, but the mass production will in a number of spheres be replaced by the small-scale production, i.e. individualizes production or production by order. Namely, the new age and new technologies enable different approach than

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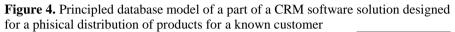
the approach used in the age of mass production. The production of today is in a way returning to the fundamental principles of craftsmanship when the products were mainly produced by order and for the well-known consumer. This type of production used to be possible because relatively small circle of people (usually noble gentlemen) had resources to buy the products tailored specially for their needs. Today the capabilities of the computer aided machines enable individualized production. Along with that, the awareness of people has changed significantly in the last fifty, and especially twenty years, and there is relatively high consumer awareness about the individuality of the middle class population, and also the need to behave according to the principles that have been reserved exclusively for the wealthy consumer layer in the past. In addition to the growth of middle-class purchasing power, what is significant is the ability of the new industry to produce individualized products at a broader consumer base at acceptable prices.

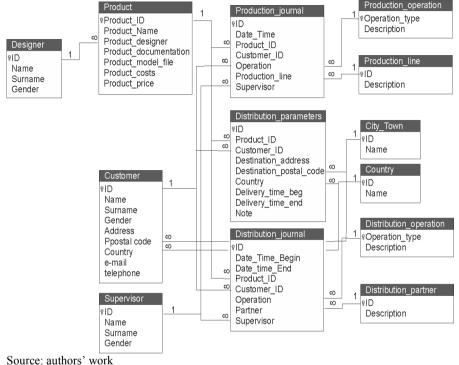
The very course of the production of individualized products according to the principles of industry 4.0 with the application of the principle of relationship marketing takes place according to the following flow chart:

- 1. Communication with the consumer
- 2. The consumer shows his interest
- 3. The negotiation with the consumer which result with the idea design of the product
- 4. Design of the 2D/3D product model product virtualization
- 5. Product presention to the customer with the use of virtual reality
- 6. Model alignment with the customers' desires finishing of the 2D/3D model
- 7. Obtaining consumer consent for product manufacturing
- 8. Creating CAM solution for product manufacturing
- 9. Product manufacturing for the known customer
- 10. Storing 2D/3D models and CAM solutions in data repository
- 11. Preparation for product delivery
- 12. Transport and product delivery to the customer (Obraz, 2016)

The entire process described with the outlined hologram is in the system of relationship marketing application tracked through CRM software solution. The application itself takes care of the interaction with the consumer through the communication process and the recording of 2D/3D models as well as CAM solutions. The CRM system is a complex software solution with extensions as CAD/CAM programes, virtual reality programes, dana warehouse programes, and also business intelligence programes. With regard to the focus of the research on all the applications that make up the integral CRM software system a particularly interesting part is the product distribution process. Since the product distribution process management is one of the CRM software application segments that experiences the most significant changes in the concept of 1: 1, its application and integration into the CRM system requires the elaboration of a database model that supports tracking the product distribution process along with the applications potential provided by geolocation systems. Database model in its essence presents principled platform on which specific

software solutions could be devloped, i.e. modules in the function of the part of a CRM system which is aimed for support and/or automation of supply chain management. Figure 4. shows principle database model of a part of CRM software solution which is designed for phisical distribution of products for a known customer.





# 4. CONCLUSION

Thanks to technological development precisely, modern society found itself in a state of good welfare in the middle of last century, as industrial production potentials were able to produce enough products to meet the needs of the population of that time for industrial products. Of course, it should be taken into account that this is a period in the history of human society when the needs of the population were relatively low and uniform, so this is the period of mass production of products with a relatively small assortment. However, this situation led to significant changes in market conditions because the buyer, i.e. costumer practically for the first time from the industrial era came to a better market position than the manufacturer. Manufacturers tried to respond on this condition with methods of sales promotion, i.e. with finding the optimal ways to persuade the customer to buy the products. Since these efforts

haven't been giving good results in long-term, because the buyers were becoming more careful, and it was harder and harder to persuade them to buy products, the solution was found in the new paradigm that was focused on the customer, not the buyer, i.e. the needs of the customer. This new paradigm, i.e. marketing, started from assumption that if the products which customers actually need are produced, then it won't be necessary to persuade them excessively to buy the products. That's why marketing puts research of customers' needs into the origin of its activity, and as a result of its action, it is a product that meets the needs of consumers.

In the time marketing was originated, the needs of customers were relatively low and limited, so with the research of customers' needs through marketing research, marketing strived to learn about the average needs of the average consumer set. The mass production that then prevailed produced average products for average consumers. As time went by, and as industrial potentials grew, mass production for the primary consumer set gradually replaced production for smaller market segments. This change in any case also contributes to the significant strengthening of the middle class and its purchasing power in developed industrial economies. The growth of the general level of information, knowledge and self-awareness of people, especially in the nineties of the last century, significantly contributed by the global information network Internet, brings ever more significant emphasis on the individual needs of individual consumers, to which marketing responds with the new developmental version or marketing 1:1, which is soon becoming a relationship marketing. As already pointed out, the individual needs of consumers, which in a way represent a return to the original production principles that were present in the period of craftsmanship, and a kind of return to the original marketing principles that initially advocate satisfying the individual consumer needs, has enabled the development of new technologies and new manufacturing paradigms united by the concept of industry 4.0. Industry 4.0 enables production of products for a known customer. Contemporary CRM systems as applicative level of relationship marketing enable permanent communication with customer and through that learning about and satisfying the needs of customers. Consequently, modern times, thanks to the potential offered by the modern industry and information and communication technology, enable the realization of a paradigm of individual production at reasonable prices for the known consumer, thus radically changing the way the modern society functions. Certainly mass or large-scale production will not completely disappear, but it is expected that its share will decline more and more with the simultaneous growth of individual production for the well-known customer. Changes in the production mode also require changes in product distribution. The problems of change induced by new concepts in production and their impact on changes in distribution were the focus of this research. The research has offered a solution to the fundamentals of the CRM system component that dealt with the distribution of products under the new business conditions through a principled database model of a part of the CRM software solution intended for the physical distribution of products to a known consumer. These research findings are the basis for further exploring and offering scientific solutions to the advancement of CRM software systems in terms that define the framework set by Industry 4.0 potentials.

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# ROLE OF CRM IN SUPPLY CHAINS USING THE PROCESS PORTAL

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#### Abstract

The expansion of customer orientation of entities operating in the logistics chain is the primary objective in the cargo transport services market. Focusing on specific customer processes is one way how to adapt the offered services to the customer's requirements. The aim of the study is to introduce the possibilities of application of the Customer Relationship Management (CRM) in logistics chains, in that the main role is the relation between the customer and forwarder or cargo operator.

The definition of the CRM and its enforcement as a philosophical means of providing the services in the transport market leads to the implementation of a process portal that supports the full range of processes, and in turn generates a comprehensive transportation product. It means creating an operational and economic concept that combines the potential of CRM and Internet portals cooperating with the concept of operating systems. It includes marketing, sales and service processes, as well as the operation of the portal and the customer support process. In order to support these processes, the main features of information systems adapted to different process tasks are introduced. In these relationships, it is necessary to specify the coordinator of the logistics chain, which may be a freight forwarder, intermodal transport operator, or perhaps even a cargo operator. The realization of the process portal implementation in the context of CRM allows the supply chain coordinator to focusing on individual customer needs, as well supporting the entire customer process of transport and logistics using modern ICT. The specific feasibility of the process portal will depend on the operator and the environment. The decision-makers are customers, partners, accessibility and existing ICT infrastructure. The process portal is a tool to promote a

coordination of freight transport in order to use sustainable transport modes and providing services at the required quality level.

Key words: process portal, cargo operator, logistic chain, transportation services, comprehensive product

## 1. INTRODUCTION

The customer usually requires several products and services in the customer process. They must find out for themselves (e.g. the goods transport process) by contacting multiple sellers (for example, freight forwarders, and carriers), evaluating bids and coordinating actions (e.g., finding bids, shipping conditions for different carriers). Sometimes they have a little experience of these processes. Modern companies have moved on to support the entire customer process. Enterprises offer all the products, services and information the customer need in a single place, leading them through the process and adding value. There are integrators and specialists for these processes. In this process, an enterprise aggregates all services and information for a particular customer process. In doing so, they will integrate their own services and services provided by co-operating partners. Products and services can be implemented on a so-called process portal. An integral part of the process portal is the CRM strategy (Customer Relationship Management).

CRM is currently often appearing as part of a company strategy in different sectors. CRM with the customer's needs is in the focus of the business, whereby the company redefines its processes and jobs, and then afterwards it will support the appropriated technologies. Modern software technology allows the creation of a detailed client profile by keeping its purchase, payment, and contact service history in the database. This information, when properly used, becomes an effective tool for non-price competition. Knowledge of customer preferences allows you to increase sales volume without using a costly advertising campaign. The CRM system built in a professional way will positively affect the business. The result is a change in the company's thinking from product-oriented to customer-oriented, and consequently, profit growth and business goals.

The CRM approach has received increased attention as a marketing concept during the last decades, both amongst practitioners and in academia, for instance Sin et al. (2005) and Vorhies (2009). The number of papers and books on CRM appears to be increasing incrementally, and the implication from this is that a new subdiscipline of marketing research is emerging. There is a great variety of topics that have been addressed in CRM research. There is a need for reflection on this establishing research field, and consideration must be given to identifying trends and relevant topics for further research.

A fundamental problem in CRM research is that, at present, no common definition what CRM is. The author prefers perspective to see CRM as a matter of integrating business processes in an organisation, for example Buttle (2004), Khalid (2001), Palaram (2010), Becker (2009), Chang (2010) and at the same time as business strategy (Morgan, 2009 and Dutu, 2011).

Not to mention that most of known studies did not provide a theoretical or a practical model for the process portal in context of CRM processes adapted for logistic supply chain. According to the above, the main problem of the research is the extent of the relationship between CRM and process portal in the logistic chains.

In the research were used the basic methods, as analysis, brainstorming, synthesis, methodology of process imaging and others. The main research uses process modelling, process analysis as well interview with experts in the field of CRM and in the field of supply logistic.

The aim of the paper is to analyze CRM processes following the definition of a process portal in the transport sector. This concept is intended to bring about the development of services provided in rail transport and logistics. Throughout logistics and distribution chains it is possible to consider different entities that will be the operators of the process portal supporting the customer process of transportation and logistics. Attention is focused on forwarding and cargo operators (railway undertakings).

# 2. CUSTOMER RELATIONSHIP MANAGEMENT

The rapid development of the application of Customer Relationship Management (CRM) and software solutions has produced a numbers of definitions, for example see Danglmaier & Helmke (2001), Bach & Österle (2000), Schmidt (2001), and Lendel (2009).

These have common features. This definition is often used:

Customer Relationship Management is a collection of marketing, communication, business and service processes and an organization (enterprise) supported by an appropriate organizational structure and technology. They enable them to manage customer relationships, tailor their offers according to their needs and wishes. These relationships then have a direct impact on the rationalization, optimization and overall efficiency of all activities that are somehow related to these relationships. Customer relationship management is part of the corporate strategy and becomes a part of corporate culture. Technologically, it is increasingly exploiting the potential offered by the Internet.

Customer Relationship Management is therefore an enterprise concept aimed at acquiring customers and maintaining long-term relationships with them. It is often referred to as CRM by the English Customer Relationship Management. However, CRM needs to be understood as a concrete solution for customer relationships, particularly in the area of information technology. CRM is a tool to help improve the way you work and communicate with your customers, to convince them of the benefits of a long-term partnership, to consolidate the market position between sales, customer service, marketing, and all the components that work with the customer. CRM integrates human resources, processes, and technologies to maximize the relationship with all customers, including "e-customers", in-house customers and vendors. CRM is increasingly using the Internet and mobile technologies.

CRM goes considerably further than the classic marketing that is focused on selling products to a group of customers. The focus is on keeping the customer with

respect to the surrounding market where the customer has more choice than in the past. Instead of trying to convince as many customers as possible that the currently available product or service is the best solution to their problems, suppliers are currently focused on getting the best for their customer. They are then subsequently trying to meet those needs as much as possible.

Creating a customer database, which will increase the sales volume, is a process that begins with basic information about customer purchases. In particular, they need basic information such as a name, mailing addresses, e-mail addresses and phone numbers, but also other information as a way of communicating personal interests. You can still move a step further with these types of customers so that they evolve by using CRM solutions. The imposition of a past relationship with customers can build the basis for personal information on every customer.

If the enterprise is able to satisfy their customer, this is a major success. However, it is equally important to know, as they had to, why. This information will form the basis for further decision making. One of the most important pieces of information is how much this company gained and what it cost them. For these reasons, it is therefore imperative to transmit information to the opposite direction, that is, back to the management and evaluation systems. Otherwise, there is little likelihood of successful decisions and eliminating unsuccessful ones.

## 3. CRM PROCESS

Implementing the management concept with customers requires reconsideration of customer-related business processes that contribute to the business model.

The implementation of CRM is related to the implementation of the process portal and the definition of sales channels. Process architecture must be tailored to specific requirements according to the number and type of channels used, while IS architecture is influenced by sales channels. Many features are completely independent of the sales channels, while some are relevant only to certain channels. The four channel types of "man-man", "man-machine", "machine-machine" and "multistage channels" (Stäger, 1999) will be distinguished by the characteristics of the various channels important to the transport undertaking.

CRM activities are ongoing in marketing, sales and service processes. In principle, the customer in the interest phase (start of contact) is served by the marketing process. Contacting during the recovery (advisory) phase as well as the buying phase is ongoing in the sales process, and part of the purchase phase as well as the after-sales activity is covered by the service process.

In a complete customer process, a customized shopping cycle usually runs multiple times. It can then take place on a process portal that will support the entire customer process - marketing, sales and services.

The basic and first step to understanding the customer is to know all the products and services they use. This is difficult if the customer communicates with the company in different ways (personally, by telephone, e-mail, etc.). The customer expects that all these so-called sales channels are equivalent and that all previous contacts with the company will be known to employees. A number of products have been created to record all customer contacts (CRMs), which will provide information on previous interactions during the next contact (the necessary link to analytical CRM). It is important that these applications are accessible to all employees who come into contact with customers. Contact recording increases the consistency of mutual communication, but does not lead to a perfect understanding of customer needs and wishes. Each customer has an individual behaviour, but some groups of customers have similar needs. In order to do this, we need to analyse the information we collect and look for links between them. This is an analytical CRM, a set of tools for analysing and predicting customer behaviour.

A key issue for the proper commissioning of all CRM systems is the interconnection of all components of these systems and integration with other enterprise systems and processes. Otherwise, there is a risk of fragmentation of customer data, duplicated business activities, uncoordinated campaigns and unscheduled sales and services with all the negative consequences, such as increased costs and loss of customers.

# 4. PROCESS PORTAL TASKS

The first step to the process portal is to create the Internet portal. Many internet providers have adopted the concept of a portal and called their own sites with portals where they provide search support by various search engines (e.g. google.com). Although the portal is defined as "a website that the user uses as a starting point from which he or she uses the internet or uses it as a point of reference to which he is still returning" (Gašparík & Lendel, 2010), the concept of the portal now has a lot of wider practice significance.

Pils (2000) defines the Internet portal with the following characteristics:

- The portal supports the user or their needs,
- Offers different functionalities for specific target groups, based on business processes or personal preferences,
- Bringing together the interests of customers and users, collecting the various data sources centrally and providing aggregate information from them. This creates a unified surface for different data and system platforms.

The Internet portal differs from the classic website by integrating the activities of different sources and the selection and preparation of activities is tailored to the requirements of the target group of the Internet portal.

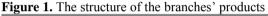
Integration can be achieved at multiple levels. In the simplest case, the Internet portal provides only lines grouped (e.g., links to internet pages), integrating all the activities into a single surface with a highest level, so the user can no longer directly see from which source the contents come from. Activities include not only information but also various applications such as discussion forums, auctions, ordering or execution banking systems. Different sources can represent different systems in one enterprise of the portal operator or different partners who offer their activities through the portal.

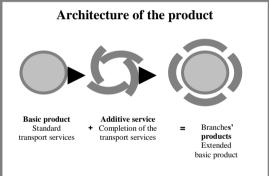
Internet portals along with operating systems and the CRM concept form a conceptual basis for process portals.

Both web portals and process portals integrate information and activities from different sources and the customer is available in one place. While the web portal is just one web page with certain properties, the process portal is an economical-business concept that supports customer service orientation through the use of the Internet portal. Process portal activities are not only available over the internet but any sales channels can be used as appropriate. For economic reasons, however, most activities and information are offered over the internet. Typically, individualized activities are provided on the WWW page.

The portal operator defines the business strategy after assessing its position on the transport market. It is necessary to offer a comprehensive solution to its needs, i.e. the overall sector product, not only the relocation from point A to point B, but to evaluate this basic product by ancillary services (see Figure 1).

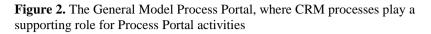
A process portal is a customer interface. The portal operator focuses on the products and services of various vendors and third parties with whom cooperation begins. They are specialized in producing competitive products and providing them through a process portal. When a portal operator makes some products or services, it combines them with partners on their own portal.

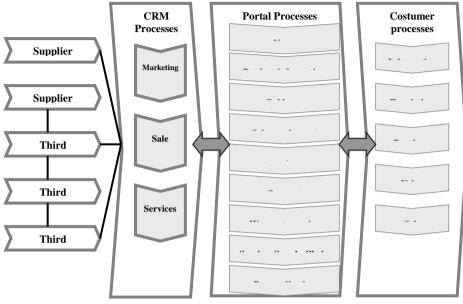




Source: Gašparík et al., 2016

From the operational and economic point of view, the cooperative operating system is the basis of the process portal. Operating systems address customer problems fully and efficiently. Therefore, individual isolated activities have so far been combined into integrated solutions that are needed for integrated problem solving. Often, operating systems are created by cooperating with external partners. An important activity of the process portal operator is to integrate proprietary and partner products and services. The frame design of the process portal structure is shown in Fig. 2.





Source: Schmidt, 2001

## 5. PORTAL OPERATOR PROCESSES

In the process portal, all customer contacts have a relationship to CRM marketing, sales, and services. These processes are focused on the customer process or, more generally, on the purchasing cycle. When a customer interface is a process portal, then CRM processes are responsible for providing customer-driven activities through a process portal.

Other, mostly highly standardized services provide a process portal for electronic service providers. As a rule, it is the execution of a payment transaction, the execution of logistical activities or the provision of product catalogues. Electronic service providers are specialized in providing cost-effective activities on a large scale.

As part of the business architecture, it is necessary to process the strategic issues and options of the process portal operator, which will define key strategic components such as services or co-operation.

The process portal model characterizes the proposed processes and roles of the railway transport company in the provision of services. Compared to classic product sales, all the activities are associated with the marketing process, sales and services, but only the key activities cannot be attributed to the process portal operation. For complementary and networking activities, we need to design additional activities - the Portal Process that provides standard activities and customer support process that provides personalized activities (Keil et al., 2016).

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The marketing and portal operation processes are managed by the portal operator and the sales, service and customer support processes are managed by the customer. The activities of marketing the provision of services consist of various sub-processes:

- Customer contact process involves customer interest following active contact of potential and existing customers,
- Sales management is driven by customer requirements,
- Product management represents the preparation and provision of products by the railway undertaking to customers, and is shown by operational efficiency,
- Service provision is an activity that occurs while providing products ordered by customers.

The marketing and portal traffic processes can be easily standardized, but must be tailored to the needs of a particular customer process or segment, but they are carried out everywhere without changes throughout. Conversely, only standard procedures can be specified for customer-driven processes that are modified in individual cases.

The basis for the formation of a business strategy is the coordinating position of the subject in the production chain. In terms of customer integration and bidding disintegration, an enterprise running a process portal should be the only entity the customer communicates with. The customer must be able to provide quality services, including additional services. An enterprise operating a process portal, together with its partners, offers a comprehensive range of services.

In the case of provision of transport and logistics activities, i.e. in the transport of goods and related services, it is important to identify the entity that will be the operator of the process portal.

The first option is that the process portal operator will be a rail transport company providing freight transport services.

The second option is that the process portal operator will be a forwarding company. The forwarder is, in view of his position, destined to operate a process portal.

A portal operator who does not produce any goods or services easily achieves credible neutrality. However, it may have difficulty in obtaining detailed product information from different vendors and have access to just a few customer data. For example, an established railway transport company has access to extensive customer data and information at least on its own products. However, to achieve neutrality, it must take measures (e.g. organizational or legal separation of the process portal from the realization of activities or cooperating with competitors).

The process portal operator must define what activities it will offer on the market and which customer processes it wants to promote. Processes to which they have procedural competences or can easily build are generally preferred. Based on the customer process, the specific activities will be offered, which can be provided separately (own key competency) and provided by external partners. The boundaries of the offered activities are again based on customer activities. They should merge those activities that are related to each other.

Another aspect is the business brand under which the operator will operate. Customers have greater confidence in portals that are operated under familiar names. An important competitive factor is the reach. Just by using the Internet as a sales channel, the potential reach is multiplied. An enterprise that can really extend the reach of its own process portal has a competitive advantage.

Reported customers are not generally homogeneous in relation to their requirements. Depending on the number, age, transport, and distance, they have different requirements and are not as profitable for the portal operator. The target group is thus divided into customer segments for which the spectrum of activities is determined.

The third dimension, apart from activities and customers, is sales channels. If the customer requires total support for the access media, an enterprise must defined in the channel strategy which distribution channels it will use. An important role is played by the requirements of the customer process, the suitability of the activities for certain channels as well as the economic efficiency of the individual channels.

As a rule, the portal operator cannot provide all the activities themselves, so a cooperative concept is needed to co-operate with a partner. Different models or combinations thereof may be established in cooperation. The Neutral Portal Operator should allow access to different vendors without directly cooperating with them. Getting information is difficult in this case, but it is made easier by the Internet. If the partners undertake contractually, they are mostly obliged to provide information and conduct activities. However, there is a risk of a loss of neutrality. In any case, exclusive contracts with individual partners must be ruled out.

# 6. ANALYSIS OF CUSTOMER PROCESSES IN THE LOGISTICS TRANSPORT CHAIN

The process of designing process architecture and its evaluation is a customer process. The basis is a list of all the activities from which you can build a specific customer process.

The design of the main, management and support processes is displayed in the process map. The activities of the process portal are generally focused on specific customer activities, but they can be derived from a generalized, independent customer process. Based on these general activities, it is possible to construct any catalogue and lists that support customer processes in organizing different activities.

Basically, activities can be offered by any sales channels. For example, a freight wagon catalogue is published on the Internet, provided in an information office on paper or sold in book form. Not all sold channels are suitable for all activities. Often, many activities are provided for economic reasons only via cost-effective channels such as the Internet, in particular complementary activities to support customer processes that do not directly contribute to the business outcome.

Various activities vary widely in their features, leading to inconsistent process requirements and information systems that support the delivery of activities. To simplify architectural assessment, we suggest categorizing individual activities. Individual categories are assigned to the individual processes that are responsible for providing activities. The activity categories created will be applied in the various phases of the proposed architecture.

# Figure 3. Position of railway transport in the logistic system

## Logistic concept of distribution

- Company logistic system (JIT, Kanban)
- Distribution logistic ("door to door")

# Logistic activities

- packing
- classification
- storage
- · cooperation with forwarders and operators
- · coordination of logistic chain
- advisory services and distribution

# Forwarding• Cooperation with transport operators• Coordination of transport chain• Tracking and tracing• Advisory services in transportationTransport-contracting activities• Processing of transportation documents• Customs clearance• Loading, unloading, transhipment• Operations with shipment during transfer• Tracking and tracing of shipment• Advisory services in railway transportation• Railway transportation• railway station – railway station• private siding – private siding

Source: Gašparík et al. 2016

When targeting a railway enterprise to a customer, it is necessary to know not only the transport needs of the customer, but also their wider context. In Fig. 3, the logistic concept illustrates its components. The carrier currently provides only rail transport and transport and procurement activities. Logistics activities are carried out at the enterprise level in the logistic concept. The forwarder is a link between service providers (the railway undertaking, other carriers) and customers (the production company with its own logistic concept).

The railway undertaking has two options in the logistics chain:

- a chain article that is managed by another entity, or
- a logistics chain coordinator.

# 7. A PROCESS PORTAL LAY OUT UNDER THE CONDITIONS OF A RAILWAY OPERATOR OR FORWARDER

At present, the railway undertaking is only a passive member of the logistics chain, where the customer (or forwarder on his behalf) orders the transport of goods by rail. The function of the transport coordinator for individual carriers is usually performed by the forwarder. In addition to transport, the carrier (railway undertaking or cargo operator) provides basic transport and procurement activities. The first step of the railway undertaking to provide comprehensive transport and logistics services is to become a rail operator able to cooperate on the EU market. An important step is the fulfilment of the interoperability conditions, which involves the restructuring of resources, in particular the mobile park.

The second step is the pursuit of forwarding activities, i.e. the coordination of the transport chain across different modes of transport. A comprehensive door-to-door transportation, including supplementary and logistics activities, will thus be able to be delivered to multiple entities to achieve a more efficient execution and the customer can concentrate on their core business. This means, for example, taking over the private siding operation at the customer.

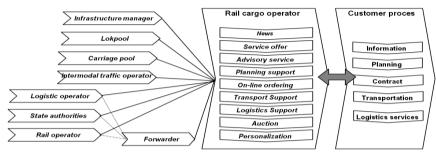
As a rule, the portal operator does not have all the competencies necessary to provide the activities. Therefore, it has to integrate several specialized partners as service providers. In order to provide these services, the portal operator will have to establish a contractual relationship with all relevant partners in the context of the trend of production chain creation and customer offer integration. The main partners are Rail Infrastructure Managers, Locomotive Pools and Wagon Pools, from which they will provide mobile means. These partners should also be trading partners in running a process portal. It is necessary to maintain the neutrality of the partners. These third parties can provide their services either through a process portal or directly to customers, and the process portal will be the intermediary only. The offer of services and other information can be prepared directly on the portal, but for example, consultancy is only mediated by the portal and must be provided directly.

The status of the railway undertaking or forwarder as a logistical chain coordinator is the starting point for defining the subject as a process portal operator.

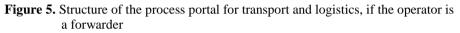
The process portal structure is derived from the general model shown in Fig. 1, while Fig. 4 and 5 show the recommended lay out of potential process portal partners for transportation and logistics on a general level, without their specification. This will be the role of the portal operator with the process portal architecture and trade agreements themselves. Figure 4 shows the structure of the portal for conditions, and the process portal operator is a railway undertaking. Figure 5 shows the structure of the portal for conditions, and the process portal processor is the forwarder.

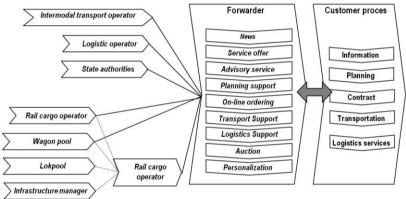
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# Figure 4. Structure of the process portal for transport and logistics, if the operator is a railway undertaking



Source: Gašparík & Lendel, 2010





Source: authors

# 8. PROPOSAL OF PROCESS PORTAL OPERATIONS FOR TRANSPORT AND LOGISTICS

The composition of the process portal for transport and logistics is not dependent on the operator.

The proposed customer process of transport and logistics is initiated by customers, mostly by forwarders, by defining their transport requirements and logistics activities. The process portal will support the planning of the entire customer process of transportation and logistics activities, and the portal operator will provide the potential customer with an individual offer including pricing. The customer assesses the need for transportation only as part of the distribution process of products, goods or raw materials, and its interest is to make this process as efficient, top-quality and cost-effective as possible. In this respect, the operator will develop a complete transportation and logistics process plan for the customer as a comprehensive product (see the comprehensive product Figure 1). If a customer asks to schedule certain activities themselves (e.g. explicitly designates a mode of transport, a transportation route, a railway wagon, etc.), the process portal offer will be available to them. The Process Portal will offer an overview of products, shipping conditions, wagon catalogues and shipping aids. They are also provided with a counselling service.

The customer will provide the necessary identification data and documentation and issue an order for the required shipping and logistics services. By uploading the shipment for shipment, the forwarder or railway undertaking is responsible for the transport and implementation of the agreed services.

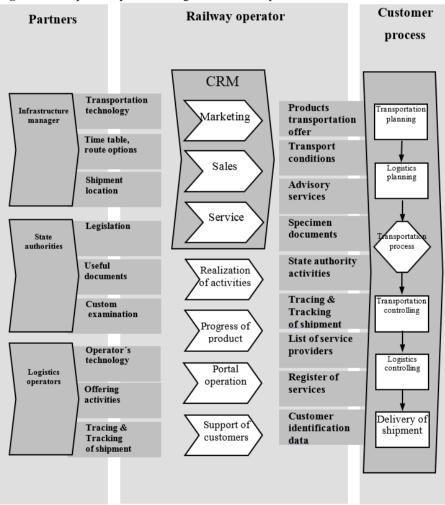


Figure 6. The process portal for logistics and transport

Source: Gašparík et al. 2016

The portal operator informs the customer of the arrival of the shipment at the agreed place where it will be handed over to the recipient. The recipient can track the position of the shipment from the start of the shipment itself. Before the shipment arrives at the agreed destination station, the customer receives notification that the shipment is set to arrive. It is also informed about the course of logistical activities (unloading, transhipment, storage, sorting) and if these activities have been agreed with the operator portal, and respectively with his partners. After receiving a shipment, the customer process ends with financial compensation for the services provided (usually the sender applies).

The process portal has to provide all the activities and operations that this customer process consumes. The framework activities are shown in Figure 6 from the viewer's point of view. The customer process of transportation and logistics as well as the activities consumed by these tasks are summarized in Table 1.

Tasks in customers process: transport and logistic	Activities				
Definition of the	The offer of transportation services				
requirement for	Offer of logistics services				
transport and logistics	Customer identification information				
activities	Goods data				
Transport and logistics	Analysis of customer requirements				
activities planning	Transport guidance				
	<ul> <li>Logistics operator offer</li> </ul>				
	<ul> <li>Railway infrastructure information</li> </ul>				
	<ul> <li>Conditions and technology of transport</li> </ul>				
	• Transport uniform rules and tariff				
	List of railway stations				
	• NHM code				
	• DIUM – distance table				
	• Timetable				
	Price calculation				
	• Overview of the requirements of the state authority				
	Freight wagons catalogue				
	Transport units catalogue				
	Transport tools catalogue				
	Offer of transport insurance				
Order of transport and	<ul> <li>Transport and logistics activities planning</li> </ul>				
logistics activities	<ul> <li>Identify data of consigner, consignee and payer</li> </ul>				
Contract of carriage	<ul> <li>Transport and logistics activities order</li> </ul>				
	Order of wagons, transport units and tools				
Loading	• Time and place of apposition of wagon				
	Delivery note				
	<ul> <li>Loading rules of wagon</li> </ul>				
	Weight of shipment				

Tab. 1: Tasks and costumer activities in the transport and logistics process

	T T T T T T T T T T T T T T T T T T T				
	Logistics operator offer				
	• Forwarding and logistics operation (choice of wagon,				
	loading operation, etc)				
Creating the transport	A shipping report				
documents	Transport documents				
	Price calculation				
State authority	<ul> <li>ID number of consignor, consignee and payer</li> </ul>				
providers	Transport documents				
	Custom documents				
Changes by	<ul> <li>Transport and logistics activities plan</li> </ul>				
transportation	Requirement of transport of carriage				
Acceptance of	Disposition with shipment				
transport and logistic	• Liability, formal reports				
changes					
Tasks in customers					
	Activities				
process: transport					
and logistic					
Monitoring of carriage	• Transport and logistics activities plan				
	Information about the shipment location				
Arrival of shipment to	• Entry in the Delivery Book				
delivery station	• Entry in the Wagon Book				
	• Writing the formal reports				
	Activities of the state authority				
Organisation of	<ul> <li>Taking of shipment message</li> </ul>				
unloading	<ul> <li>Logistics operators offer</li> </ul>				
(transhipment)	<ul> <li>Forwarding activities</li> </ul>				
Wagons handover	End unloading message				
	Unloading of wagon				
	Cleaning of wagons				
	• Return sheet				
Organisation of	<ul> <li>Technology of logistic operator</li> </ul>				
logistics activities	List of logistics operators				
=	Activities of logistics operators				
Shipment arrival	Information about shipment location				
message	L				
Take-over of shipment	<ul> <li>Transport and logistics activities plan</li> </ul>				
r r	Transport documents				
	<ul> <li>Report of delivery of wagon, transport units and</li> </ul>				
	tools				
Financial	Consignment note/invoice				
compensation	<ul><li>Individual calculation of price</li></ul>				
compensation	- marvidual calculation of price				

Source: authors

In table 2 there is a summary of the activities provided by the process portal for transport and logistics within the customer process. Activities are broken down

according to the classification listed as key, supplementary, networked, standard and individualized.

Certain services of the process portal will be provided by the shipper or Railway undertaking, in particular those belonging to its core competencies. This is important, for example, when offering individual sellers. Additional services are provided by the portal operator in a supply manner through business partners.

However, customer-driven sales, customer service and customer support must be tailored to the specific customer process.

Processes are poorly structured and demanding not just in the customer process, but also in the processes of the railway undertaking. Individual tasks do not follow in a single order. Some aspects of the technological processes in rail transport and logistics have been published by Halás et al. 2013, Ližbetinová et al, 2012, Čejka et al. 2016.

Net activities		Personal settings and support ID data of consignor and consignee Valid contract of carriage Data about the shipment Distribution plan
Additional activities	Specific information by costumersprocessesTransport rulesEffective plan of transportLogistics activities (warehousing,transhipment, sorting)State authority activitiesInsurance of transportLists of external partnersManagers of infrastructureRail operatorsLogistics operatorsIntermodal transport operatorsRoad hauliersLocomotive and Wagon PoolsCustom AuthorityTransport agreementsTransport documents (domestic andinternational consignments notes)Information about products of thirdsubjectsTechnology of logistic operatorIntermodal units catalogueCustom proceedings	Messages managed by the real situation Information about the changes in transport Shipment locations Actually prohibition of loading the shipment

Table 2. Process Portal Activities for Lo	ogistics and Transport
---	------------------------

		contract,			
		Contract of warehousing, rental			
		Forwarding contract			
		Contract of carriage			
$\mathbf{K}$		Contract			
ey		An order of carriage			
ac		Customs documentation			
tiv		tools			
Key activities	Exchange rate	Catalogue of wagon and transport			
	Additional services	Lists of tariffs , DIUM, NHM codes			
	Special solutions	Supports			
	Transport services	Logistics activities planning			
	products	Transport planning			
	Information about forwarder	Individual recommendations			

Standard

Individual

Source: authors

# 9. CONCLUSION

The customer assesses the need for transportation only as part of the distribution process and their interest is to make this process as efficient, top-quality and costeffective as possible. In this regard, the process portal operator as a logistics chain coordinator will develop a complete shipping and logistics process plan for the customer. Designing a process portal concept involves coordinating activities in cooperation with business partners to provide a comprehensive product.

Implementing Customer Relationship Management in the field of transportation technology itself will build on ICT and human resource implementation. From a CRM point of view, however, rail transport technology is only a means of achieving customer satisfaction. The customer perceives the whole process as a whole and evaluates its outcome. In conjunction with the forwarder's activities, the desired result can be achieved.

In particular, the customer requests:

- Minimum time from the start of the transport request to its implementation,
- Simple administration associated with the carriage of goods,
- Acceptable price,
- The possibility of performing cargo handling only on working days and mostly at the time of day, as long as these operations are carried out by themselves and the production is of a time-discretionary nature (the number of such customers in the system of individual wagon consignments is predominant);
- Regular and numerous connections,
- Reliable shipment of intact shipments,
- Fast delivery at certain times for some commodities,
- Accurate information about the services offered and the current state of transport,
- Additional complementary services completing the complex product in the logistics chain.

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The railway transport company only has a few possibilities to implement the required quality requirements of the customer. It is limited by economic efficiency, the technical and technological parameters of each wagon system, as well as other limitations. The interchange between customer requirements and the possibilities of a railway undertaking is most often reflected in the speed of delivery and the cost of transport and other services. It is important to regularly measure customer satisfaction (Stopka et al., 2016 and Černá et al., 2017).

The customer assesses the access of the railway undertaking in particular to the planning of the shipment and to inform on the course of the shipment. In a commodity organizational structure, the customer is easier to orientate and selects the department of the commodity he wants to transport. The solution for anything that is unclear or for problems is facilitated by new communications and sales channels.

To support the entire transport process technology, the creation of a process portal for transportation and logistics processes will be significantly contributed to by the implementation of modern IS / ICTs with a considerably accelerated and accelerated consultancy processes, transport orders, including complementary and logistics activities, to support the entire customer transport process.

The customer submits an online order. The data they present will be stored in a single data warehouse, to which all workers involved in a particular shipment will have access. As a result, the customer will be spared from duplicate data provision and employees will work more efficiently. The form of the bill of lading will be exclusively electronic. Higher integration of information systems within the enterprise will improve the synchronization of the shipment transport activities themselves not only at the shipment station and destination station where the transporter and the carrier is the most cooperating, but also at the station where the customer enters the process only in the event of extraordinary circumstances.

The proposed process portal concept provides the basis for exploring other aspects of logistical chain support through a process portal, especially with an emphasis on the specifics of the transport sector when planning detailed activities. Presented descriptive model is a start point in modelling process to reach an applicative model of process portal, database model, IS model etc. In the future research authors will extend the suggested model with details which should make the model more usable in praxis.

The CRM research field is heavily dominated by the experiences from large organisations and this is a crucial bias in CRM research. Supply chain logistics and transportation especially is very important in economies in generally. The adoption of a CRM approach, including its emphasis on ICT enabled marketing practices, is a means of remaining competitive – and also in developing new competitive advantages in this new competitive landscape. There is an evident need for research on CRM practices, including the implementation of the CRM approach, in a supply chains and in transport companies in general.

It is an accepted fact that the concept of customer relationship management neither has been fully verified, nor empirically assessed to determine the strength of the relationship between dimensions of customer-relationship management and logistic chain. Moreover, this study uniquely extends the body of knowledge by explaining the theoretical possibilities of the mediating role of CRM (planning and implementation) in the relationship between process portal and logistic chain performance.

It is worth mentioning that this paper will also raise awareness among logistic operators to pay more attention to CRM dimensions, process portal capabilities, and assist them in improving logistic chain and competitiveness. However, the fact remains that this study has its limitations. First, because it is in dire need of further verification by collecting data from the logistic operators and transport operators to test the proposed model and further investigate the hypothesized relationships. Second, the model is more focused on the logistic chain and therefore, there is a need to test it in different sectors such as the financial sector.

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# THE ROLE OF MODERN INFORMATION TECHNOLOGY AS AN IMPORTANT ASPECT OF BUSINESS INTELLIGENCE IN THE OPTIMIZATION OF LOGISTICS SYSTEMS

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## Abstract

Business intelligence as set of methods for managing large amounts of information and knowledge about the internal and external business environment in which companies operate simplifies the decision making process and provides competitive advantage. However, business intelligence deals with a great quantity of information, which imposes the need for finding better ways of data structuring.

This paper is based on the hypothesis that the systems of business intelligence are specific and complex information systems where, apart from the constant need for the comprehensive and standardized development, an increasing need to adapt to particularities of business and specific processes of the particular organization occur, the same as for individual users. A comparison of different information systems that provide support in making business decisions and ontology as more recent concept of artificial intelligence is presented. A special emphasis of the paper is on the ontological structure of the data in the field of logistic operations.

A practical analysis is based on publicly available business data, documents and information available on the Internet provided by the companies that offer the complete systems of business intelligence as well as on the pre-established theoretical and scientific findings of other researchers.

The methods of description, induction, deduction and comparison are used in this paper.

Key words: business intelligence, information, data, ontology, logistic systems

# **1. INTRODUCTION**

The goal of applying standards, promoting the automatic identification system and electronic data exchange in logistics processes is to improve the performance of business relationships as well as to strengthen and streamline business cooperation on the global market. Businesses become faster and more efficient, increase the entire supply chain monitoring, enable transparency of the operations and the work of each business phase and exchange, minimize errors, enable phase controls and reduce the costs of all participants in the global supply chain.

A manufacturer, retailer or distributor want and exactly must know where the items are located at any time. It is important for them to have information of where the shipment comes from and when and for whom it is intended. By applying ontology that enables the connection of different data, accurate and precise information are created and provided on all aspects of the supply chain, including transport and logistics, which are necessary for making correct and timely decisions during everyday work.

Today's Logistics Service providers (LSPs) take goods from various sources and bundle them for the same or similar destinations or sort them for different destinations. Sometimes, storage is not involved at all and goods are moved on immediately. At other times, LSPs even assemble retail displays.

For this kind of complex warehouse management it is necessary to have a close collaboration among all trading partners. Ontology help cooperation and coordination by allowing accurate real time information to be accessed by everyone involved in operational activities during business processes.

Product traceability from a manufacturer to a consumer today means competitiveness, but also reduces risk to companies as it provides product safety, product tracking, and timely withdrawal or recall orders if it is needed. Companies which are part of the food supply chain pays special attention to that, considering that they have to respect the set standards and conditions of regulatory bodies and the food industry around the world.

Today's technology helps them meet many product tracking requirements that are not always easy to meet at national, regional or global level. There is a constant need for the introduction and development of technology and the development of business intelligence in daily business. Ontological structuring of data in the domain of logistic operations facilitates the interoperability of different traceability systems and can provide precise answers to common business issues such as: does the delivery include all that has been ordered? Is the supply chain monitoring of the goods movement sufficient to optimize its movement through the supply chain? Are all the information available that are required in case of revocation or withdrawal of the product?

On the other hand, consumers want to know if the food they buy or consume is safe and contains exactly the ingredients that are declared on the packaging.(GS1 Croatia, n.d.)

Knowing the usefulness and necessity of using Information Systems (IS) in everyday work related to collecting, storing, processing and distributing information, companies strives to find and build the most optimal technological and business solution tailored to their needs. (Čerić & Varga, 2004) If we include microelectronics, computers, telecommunications and software that enable input, information processing and information displaying then we are talking about information technology. Throughout this paper, the term information system will also refer to information technology, because of today's technology development come in into all aspects of life. Therefore, we are talking about technology and information system synergy.

The business structure is conditioned by the type of business activity the company is engaged in, and there is no single information system that would universally solve the business organization. In practice, complete solutions are offered with program modules or an information subsystem (IPS) that is designed or adapted to the needs of users according to their needs. (Sekso, 2011)

Artificial intelligence has a major role in economy primarily because it helps in making business decisions. Its main goal is to provide knowledge to information systems that are expected to have people's knowledge and decides by predefined rules depending on which system is chosen as the best solution for business problems. While the information system is used for data storage from the environment.

# 2. INFORMATION SYSTEM IN BUSINESS

Information technology development dement to the improvement of management and it has taken on the role of organizing, maintaining, deciding and introducing new business principles. In 2016, the Croatian bureau of statistics published the first release on the usage of information and communication technologies in companies: 92% of companies used computers, 91% had internet access and 69% companies owned a web site. The cloud computing is used by 23% of companies as a new technology of internet service. (Croatian Bureau of Statistics, 2016) Using Intranet and Extranet in companies enables the linking of business units within a business and linking business processes that contribute to the more efficient business. The speed of the Internet connection becomes an important factor in business. Thus, through a variety of user-friendly technologies, it facilitates communication and Internet business.

Information technologies reduce business costs, speed up administrative tasks, enable decision-making in business, and increase enterprise productivity, and make this work efficient and successful. The business information system is primarily used for further use. The data is stored in the databases from which reports are made to the company required for its business. For these reasons, good programming support is needed that will process the information that is stored in the database and will be able to handle this data in a legitimate manner. From this it can be concluded that the information system supports a business system. Investing in information technology (IT) makes a big share in total company investment. The information system with regard to business management level is classified into: transaction processing system (TPS), management information system (MIS), decision support system (DSS), enterprise resource planning (ERP). One of the business planning steps is deciding, between at least two options of making decisions of the business. Because of the need The role of modern information technology as an important aspect of business intelligence in the... Dominika Crnjac Milić, Ivana Hartmann Tolić, Marina Peko

for successful and rapid business operations concepts of decision support system are related to artificial intelligence. Management support system (MSS) provides direct support to the decision and it is classified into (Čičin-Šain, 2009): decision support systems (DSS), group decision support systems (GDSS), expert system (ES), executive support systems (ESS).

## 2.1. Artificial intelligence in business

The artificial intelligence (AI) is a system programmed to remind the workings of the human brain. Russell and Norvig gave different definitions AI based on different approaches: (Russell et al., 2010)

• Thinking humanly: "The exciting new effort to make computers think ... machines with minds, in the full and literal sense."

• Acting humanly: "The art of creating machines that perform functions that require intelligence when performed by people."

• Thinking rationally: "The study of mental faculties through the use of computational models."

• Acting rationally: "Computational Intelligence is the study of the design of intelligent agents."

AI is generally classified into expert system, artificial neural networks, evolutionary algorithms, fuzzy logic, hybrid system and data mining (Nordlander, 2001). The AI plays a great role in financial service and gives great importance to business applications. Some of the business applications are: mortgage risk assessment, project management and bid strategies, financial and economic forecasts, discovery of legitimacy in price movement security, non-payment and bankruptcy estimates, etc.

Expert system (ES) is a software support system that imitates the decisionmaking ability of human experts based on knowledge and conclusions (Ye & Wu, 2014). They are designed to store specific knowledge of experts to make it available for solving problems. The development of the ES is performed using specific software such as Expert System Shell program designed for fast development, AI programming languages such as LISP (List Processing), Prolog (PROgrammation et LOGique), but also using common programming languages such as Fortran, C++, Java and similar (Nordlander, 2001). Expert systems are applied in almost all branches of human activity and vary according to activity (Mrkonjić, 2007): financial ES, medical ES, expert production systems, sales and marketing ES, education, public, scientific and other. The development of ES for commercial purposes began in the 1970s and continued to be used in various companies. There are a lot of business-based application based on the ES. Some of them are: Sales Personnel Assessment, Career Goal Planning, Market Advisor for Control of Process Control Systems, Credit Analyst Advisor, Loan Approval Predictor, Pension Fund Calculator, and many others.

Artificial Neural Networks (ANNs) are designed to copy the neural networks (NN) of the human brain. The NN is a set of mutually connected simple process elements. They solve class and prediction problems with a nonlinear connection of inputs and outputs and learn how to recognize the pattern through repeated minor

changes on selected neuronal weights (Nordlander, 2001). They are most often used in pattern recognition, image and speech processing, optimization, simulation, processing of imprecise and incomplete data, etc. In the business world they try to predict the likelihood of different problems that are mutually connected. For these reasons, large companies use neural networks to analyze current trends and evaluate future patterns based on them. One such application is the credit scoring system developed by Hecht-Nielson Co. which learns how to identify good and bad credit risks (Smith & Gupta, 2000).

Evolutionary algorithms (EAs) are general-purpose search procedures based on the mechanisms of natural selection and population genetics (Dasgupta & Michalewicz, 2013). One of the paradigms is a genetic algorithm based on Darwin's theory of evolution. According to Ben-Gurion University, the genetic algorithm should be used in case when there is no other strategy for solving the problem and the definition of such a problem is a NP- complete problem (Nordlander, 2001).

Fuzzy logic (FL) is a human-like conclusion which uses prediction of information as well. The result can be expected in the continuous range of the segment [0, 1] and not only in binary form. FL is most commonly used for controlling the nonlinear systems and modeling complex systems when there is an inaccurate model or there is ambiguity or inaccuracy in the system (Kr Dhamija, n.d.). FL in business is most often applied for solving the problem of consumer credit scoring, for analysing the income flow using regression techniques, risk assessment, etc.

Hybrid Systems (HS) use multiple problem solving techniques. Actual development of the applications does not require only the acquisition of knowledge and conclusions from different sources, but also from the combination of various intelligent technologies (Mrkonjić, 2007). For example, a combination of NN and FL results in a hybrid neuro-fuzzy system. It is important to divide the job components needed to solve the problem so that appropriate techniques can be combined to produce a good HS. Each system has its own advantages and disadvantages. Table 5. Comparison of Expert System, Fuzzy System, Neural Networks and Genetic Algorithm shows a comparison of various intelligent technologies, where the gradient characters are:  $\Box$  – bad;  $\blacksquare$  - rather bad;  $\Diamond$  - rather good;  $\blacktriangle$  – good

Ĩ	ES	FS	NN	GA
Knowledge representation	$\diamond$			
Tolerance to uncertainty	$\diamond$			
Tolerance to imprecision				
Adaptability				
Ability to learn				
Ability to explanation				
Detecting knowledge and data mining				$\diamond$
Maintainability		$\diamond$		$\diamond$

**Table 5.** Comparison of Expert System, Fuzzy System, Neural Networks and

 Genetic Algorithm

Source: autors, based on Negnevitsky, M., *Artificial intelligence : a guide to intelligent systems* (Negnevitsky, 2005)

Data mining is a process of storing data that results in finding hidden trends, patterns and legality among data. Data mining is the ability to learn in databases, data archeology, data segmentation, finding information, etc.(Nordlander, 2001)

Data mining techniques derive from statistical methods and in business operations are kept from the very beginning of storing data in large databases. For these reasons, it is necessary for companies to have a skilled analysts who will manage databases and use business intelligence, what is unfortunately not the practice today. The development of the information systems raises the question whether the data contained in databases can be used to create models that could be used to analyse past trends in business systems/subsystems and assess future business system trends over a time period.

Data mining is the most common form of use of AI in business because of its primary task: storing data and establishing legitimacy among the data. Data mining is part of business intelligence that combines a set of methodologies: data warehousing, OLAP (on-line analytical processing) - data processing, data mining.

Business Intelligence (BI) is a set of applications designed to organize and structure business information data on a regular business transaction in a way that provides analysis useful in decision making and business activity of the company. From a macroeconomic point of view, it represents a complex aggregated category that is generated by an untargeted collection of the data on macroeconomic trends in a given environment, by their organized and structured storage, searching, logical and computer-processed interpretation for the purpose of detecting macroeconomic trends or tendencies, and predicting and forecasting processes and events in macroeconomic systems. (Panian, 2005)

Supply chain optimization is based on the collection of supply chain data with radio frequency identification (RFID). BI technology in all management levels can obtain and handling information with decision support system and required data integration and useful utilisation of RFID data in logistics.(Baars et al., 2008) Information support for enterprises to real-time tracking orders, economic decision-making, and general data warehouse and online analytical processing and data mining is part of business intelligence. Typical applications based on business intelligence are intelligent warehousing management system (WMS), intelligent transportation system, individuation analysis, logistics software. (Zhao & Huang, 2009).

## 3. ONTOLOGIES AS CONCEPT OF AI

The process of building a knowledge base is called knowledge engineering. A knowledge engineer is someone who investigates a particular domain, determines what concepts are important in that domain, and creates a formal representation of the objects and relations in the domain. Often, the knowledge engineer is trained in representation but is not an expert in the domain at hand. The knowledge engineer will usually collaborate with the real experts to become educated about the domain and to elicit the required knowledge, in a process called knowledge acquisition.

To help focus the development of a knowledge base and to integrate the engineer's thinking at the three levels, the following five-step methodology can be used. (Russell et al., 2010):

• Decide what to talk about. Understand the domain well enough to know which objects and facts need to be talked about, and which can be ignored. Many knowledge engineering projects have failed because the knowledge engineers started to formalize the domain before understanding it.

• Decide on a vocabulary of predicates, functions, and constants. That is, translate the important domain-level concepts into logic-level names. This involves many choices, some arbitrary and some important. Once the choices have been made, the result is a vocabulary that is known as the ontology of the domain. The word ontology means a particular theory of the nature of being or existence. Together, this step and the previous step are known as ontological engineering. They determine what kinds of things exist, but do not determine their specific properties and interrelationships.

• Encode general knowledge about the domain. The ontology is an informal list of the concepts in a domain. By writing logical sentences or axioms about the terms in the ontology, we accomplish two goals: first, we make the terms more precise so that humans will agree on their interpretation. Without the axioms, we would not know, for example, whether Bear refers to real bears, stuffed bears, or both. Second, we make it possible to run inference procedures to automatically derive consequences from the knowledge base. Once the axioms are in place, we can say that a knowledge base has been produced.

• Encode a description of the specific problem instance. If the ontology is well thought out, this step will be easy. It will mostly involve writing simple atomic sentences about instances of concepts that are already part of the ontology.

• Pose queries to the inference procedure and get answers. This is where the reward is: we can let the inference procedure operate on the axioms and problem-specific facts to derive the facts we are interested in knowing.

The term ontology has been used in many different ways in the literature (Guarino, 1998; Guarino et al., 2009; Uschold & Gruninger, 1996), so in this section we characterize ontologies for the purpose of this work.

According to its original meaning in Philosophy, an ontology concerns the study of being or existence (Gruber, 1993; Guarino et al., 2009), so it concerns things that exist in the real world. In this paper, we use ontologies to capture mental images of the real world, the so-called conceptualizations. However, such a conceptualization has to be based on concepts, which can be instantiated for each real world situation that we may have to conceptualize. For example, a "container" can be a concept in logistics, which can be instantiated to represent specific containers used in certain logistics operations. Conceptualizations exist in principle in the mind of those whose produce them, but they have to be unambiguously communicated to others. Therefore, an ontology as an engineering artefact requires a language that allows the conceptualizations to be represented and communicated as concrete descriptions (specifications). This language should be suitable to represent instances of the ontology concepts and should have a formal semantics, which allows not only unambiguous interpretation but also rigorous analysis and reasoning. In relation to enterprise interoperability, ontologies are potentially beneficial for the following three main purposes (Daniele & Ferreira Pires, 2013):

1. improve communication and re-use of knowledge, by providing a shared understanding that reduces ambiguities and misunderstanding in the terminology adopted in a certain domain;

2. facilitate the integration of existing systems, by providing a reference model that allows translation and matching, possibly automatically, among multiple heterogeneous systems that have been developed based on different semantic representations; and

3. support the engineering process of software solutions, by providing a basis for automated specification, analysis and consistency checking of software under development.

## 3.1 Ontologies in logistics operations

In order to facilitate the process of data analysis, the usage of the ontology is proposed as a model of financial knowledge about the analysis of indicators. Logistics organizations should now be able to share and reuse data across other organizations, instead of keeping proprietary data in several and, often, inconsistent versions. Therefore, not only a logistics organization may want to be able to expose its own data outside its boundaries, but also needs that the meaning of this data, or semantics, is correctly interpreted by others, otherwise the collaboration among organizations may lead to ambiguities and serious mistakes. In other words, there is a need for semantic interoperability among logistics organizations. The ontologies are used to create the necessary knowledge models for defining and explaining functionalities in analytical tools. Using ontologies and semantic networks for a visual interface to support an information search in the BI system may help to reduce the following weaknesses of management information systems (Dudycz & Korczak, 2016):

• lack of support in defining business rules for getting proactive information and support in consulting in the process of decision making;

• lack of a semantic layer describing relations between different economic topics;

• lack of support in presenting the information of different users (employees) and their individual needs;

• difficulty in rapidly modifying existing databases and data warehouses in the case of new analytic requirements.

We have adopted approach proposed by (Daniele & Ferreira Pires, 2013), which proposes a core ontology that specifies the main concepts commonly used in logistics operations. This core ontology can be further extended for the purpose of specific logistics applications and our further development is given here. The ontology presented is being developed in the context of the iCargo (www.i-cargo.eu) and CASSANDRA (www.cassandra-project.eu) projects, which are both co-funded by the European Union under the Seventh Framework Programme for ICT. We regard a proper ontology as an engineering artefact that consists of a set of concepts and definitions used to describe a certain reality, relations among these concepts, plus a set of axioms to constrain the intended meaning of these concepts (Guarino, 1998). After detailed analysis of existing BI software for logistics and after thorough and detailed conversations with experts from logistics domain, we have been able to agree on common terminology that is used among them to describe relevant objects for logistics. The highest level of general objects in logistics would be container type, cargo type inside container and means of transport. Although "container" can be a concept in logistics, it can be instantiated to represent specific containers used in certain logistics operations, like refrigerated container, container for medicine, hazardous cargo, etc.

Single common ontology is almost impossible to create as it would get too complex and difficult to maintain. Therefore, we propose approach of networked ontologies that have in common one core ontology, which specifies the main concept for logistics domain and all case specifics would be separated in "child" ontologies.

Since ontology development is never trivial task, we could agree on informal definition that applies to logistics: "logistics is all about transporting something from a place of origin to a destination in a certain time and under certain conditions", so the key words "transport", "something", "place of origin", "destination", "time" and "conditions" are already hints to what type of concepts can be included in such a core ontology, regardless of its specific application in logistics (Daniele & Ferreira Pires, 2013).

In order to propose core ontology, we have followed approach based on topdown and bottom- up practices for ontology engineering. From a top-down perspective, the upper level concepts are specialized as defined in the DOLCE+DnS Ultralite ontology (Ontology design patterns, n.d.) for the purpose of logistics. In this way, a classification is provided for most of the relevant objects that are involved in logistics operations (for example, actors, facilities, product classes, packages, pieces of equipment and transport means) and the relationships among these objects. From a bottom-up perspective, classification of transport means, packages and dangerous goods is done, among others.

This approach allows extensibility to allow further growth of the core ontology for the purpose of specific logistics applications. For example, we could extend our core ontology with company logistics ontology, which would define all main activities and events important for companies demanding logistics services. This extension would provide definitions of special request that companies would have, for example, order of container fulfilment (for example, first heavier product and lighter on the top), special place and time of delivery, package sizes, delivery priority (FIFO or LIFO) etc. Analogously, we could extend our core ontology with a logistics documents ontology that represents all the documents exchanged in the logistics operations.

One other important feature is maintainability. It enables the process of identifying and correcting defects, accommodate new requirements, and cope with changes in logistics ontology. The minimum requirement is that a new module, which can be extended, in the network of ontologies must comply with our core ontology.

Separation of the design of the ontology from its implementation is proposed. In the design phase, concepts of the ontology are defined using natural language. These concepts and their relations are specified using UML class diagrams, and formal axioms that capture the intended meaning of these concepts are defined. UML is a popular general-purpose language that allows representation of ontology at a high abstraction level, i.e., abstracting from the ways the ontology might be implemented in actual applications. In this way focus on the concepts, relations and axioms that we wanted to specify is given, ignoring the issue of selecting the most suitable language to express them. In the implementation phase, ontology is specified using OWL DL, which allows automated reasoning to validate the correct use of axioms and relations, and make queries against ontology.

Logistics can be considered as the set of activities that take place among several actors in order to deliver certain products at the right time, right place and under the right conditions, by using suitable resources. Therefore, logistics ontology upper level concepts are presented in Figure 1 and should be:

• Activity, which denotes some action that is relevant for the purpose of logistics and provides value for a potential customer. Activities are, e.g transport, transhipment, load, discharge, storage and handling. The latter activities are fundamental activities and can be used to compose more complex activities.

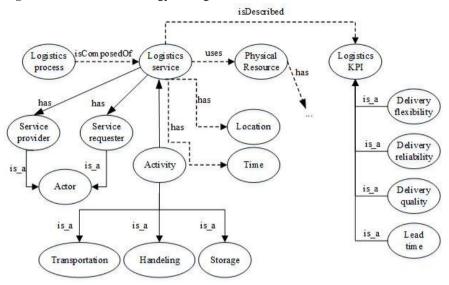
• Actor, which represents companies, authorities or individuals that provide or request activities and operate on resources related to these activities.

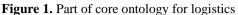
• Physical Resource, which represents physical objects that are used in the logistics activities, such as, for example, the moveable resources used during the activity of transport, i.e. the transport means and equipment used to move items to their destination.

• Location, which represents the geographical area or geographical point used to define the place(s) relevant for logistics activities. Location can be coarsegrained for scheduling, since in long term planning it is sufficient to specify approximately the place of origin and destination, such as, e.g. the Netherlands or the port of Rotterdam. However, location needs to be fine-grained for delivery, since one has to specify the precise address to which a certain item must be delivered.

• Time, which represents the start time, end time or time interval associated to activities. Since time is a basic (foundational) concept relevant for logistics, but common to other domains, the representation of time proposed in the Time Ontology (http://www.w3.org/TR/owl-time) could be reused instead of creating new ontology.

• Key performans indeks (KPI) is used for performance measurement ensures that are always evaluating logistics business activity against a static benchmark. This means that fluctuations are immediately visible and if performance moves in the wrong direction, action can quickly be taken to address the situation. When a KPI shows that performance consistently meets or exceeds the required level, it be can decided to raise the bar and set a higher standard to aspire. For example, in logistic it is important for inventory levels, stock losses and/or damages, costs of transportation, warehousing, order capture, etc. KPIs are also essential for any business improvement strategy because it provides visibility of business performance and allow objective quantitative and qualitative evaluation. (Logistics Bureau, n.d.)

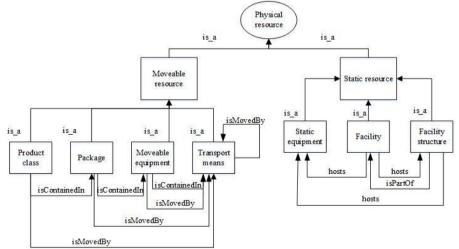




Source: Authors

Figure 2 shows part of core ontology, which focuses on the specialization of the concept of Physical Resource. A Physical Resource is specialized in a Moveable Resource, which is characterized by the capability of moving on its own or being contained for the purpose of transportation, and a Static Resource, which is used to handle moveable objects in a facility prior to their transportation.

Figure 2. Part of core ontology for logistics, focused on the concept of Physical resource



Source: Autors, based on (Daniele & Ferreira Pires, 2013)

In order to clarify parts of Physical resource concept, i.e. what is expected in implementation, here are definitions and properties:

• Product class: Object used to select proper package, moveable equipment and transport means for several logistics activities, especially for transport. The selection is based on relevant properties of the product class, such as its physical state (solid, liquid, gas), required temperature, dangerousness, etc. Properties are: Type (regular, perishable, flammable, organic, toxic, heavy machinery, bulk, medicine, expired deadline for food etc.), State (solid, liquid, gas), isRefeer (Boolean value), isDangerous (Boolean value), isOversized (Boolean value)

• Package: material used for containment, protection and movement of product classes. Properties are: Type (carton, box, crate, barrel, pallet, container, etc.), Quantity, Volume

• Moveable equipment: Reusable resource used for containment, protection and movement of product classes with or without package. A moveable equipment cannot move on its own (unpowered vehicle), but can be pulled or contained in a transport means. Properties are: Type (container, pallet, railway wagon, trailer, etc.), ID, Volume, Quantity

• Transport means: Reusable resource that facilitates the activity of transport and moves on its own (powered vehicle). Properties are: Type (aircraft, vessel, truck, train), Capacity

• Static equipment: Reusable resource that is used in a facility to handle moveable resources. Properties are: Type (crane, etc.), Facility

• Facility: Static resource (usually a building) built, installed or established to facilitate related activities in a point location. A facility can be part of a facility structure (for example, a terminal is part of a port). Properties are: Type (terminal, warehouse, etc.), Location, FacilityStructure

• Facility structure: Static resource built, installed or established to facilitate related activities in a geographical area. A facility structure may host several facilities. Properties are: Type (port, airport, etc.), Location (GeoArea), Facility

Some axioms that apply to the ontology fragment in Figure 2 are the following:

• If a moveable equipment e isMoved by a transport means tm, then tm moves e (i.e., the relation moves is the inverse of isMoved);

• If a product class pc isContained in a package p, and p isContained in a moveable equipment e, then pc isContained in e (i.e., the relation isContained is transitive);

# 4. DEVELOPMENT OF THE NEED FOR APPLICATION OF BUSINESS INTELLIGENCE SYSTEM AND DEVELOPMENT OF ONTOLOGIES IN ORDER TO MEET TRENDS IN LOGISTICS OPERATIONS

Market needs impose synchronized work of digital platforms that in a daily tasks have to link a big number of data and channelized at the right time and in the right place the valuable information needed for a successful business. The traditional way of operation in logistics operations are getting more and more virtual and business intelligence is particularly important because its use results in creating competitive advantages for companies.

The opening up of the Republic of Croatia to the global market has created a need for outsourcing of logistics services, and for the increasing use of ICT in daily work. Sophisticated technologies enable a high level of supply chain optimization, enabling multiple activities to be performed in a shorter time, while minimizing costs, but impose the need for continuous investments, modifications and advances.

In transporting goods, there are increasing needs for the implementation of telematics systems in order to ensure better resource planning and traceability of goods.

In order to speed up the exchange of data using these systems it is important that availability of data through the cloud exists.

Inventory tracking and related data collection enables them to better manage and provide better "cash-flow" of companies.

The use of various types of transport, such as road, rail, water, and air in the continuous logistics process of goods delivery defined by the term Intermodal Logistics which is becoming increasingly trendy, requires the connection of a large number of different qualitative and quantitative data.

Using of various types of transport, such as road, rail, water, and air in the continuous logistics process of goods delivery defined by the term Intermodal Logistics which becomes trend, requires the connection of a large number of different qualitative and quantitative data. Intermodal transport provides a consolidated service and develops the "Value Added Services" market. In order to increase product distribution efficiency in the supply chain, GPS Vehicle Monitoring and Geo Location (vehicles and packages) are used to optimize traffic routes, but also timely control of driver operation. Informatization has also enabled the use of dynamic systems for rout planning, which generate numerous savings in work that can be achieved with shorter deadlines and delivery accuracy, more efficient utilization of the fleet, etc. In warehouse logistics, Warehouse Management Systems (WMS) enables to measure the efficiency of all warehouse operations. The use of the collected data and their ontological linking enables to indicate work errors timely and possibility for optimization warehouse work. This system of operations allows the reduction of total costs of manipulation and warehousing of goods, reducing energy consumption, time, storage capacity and workforce.

Online retailing which becomes bigger part of the retail trade has led to new trends in the workplace, such as the use of intelligent Warehouse Execution Systems (WES), which task is to optimize equipment and human resources by pointing to the prioritization of sorting, packaging and shipping goods at the right location with minimal time.

The trend of development of e-commerce has resulted in growth and development of packet delivery, and an increase in such distribution. This type of logistics is extremely dynamic and success in this type of work is followed by respecting the phrase "time is money", but also from the awareness that timely delivery of the necessary information means an advantage ahead of the competition. The range of products delivered is very wide, inventory stocks are often or are not small, and this imposes special adjustments in the work of logistics companies. The range of products delivered is very wide, there is no stock goods at the warehouse or they are small, so it imposes special adjustments in the work of logistics companies. The use of BI and ontology of data in this segment of logistic business is reflected in the use of a transparent tracking system "Track & Trace" of package, SMS notifies of delivery expiration, online delivery announcements, payments on the web and support of working with new forms of delivery networks such as "Click & Collect". It provides optimal use of resources and business processes to minimize costs. Particularly important in this type of business is the rapid transfer and processing of data on the goods being delivered and the time of delivery.

#### **5. CONCLUSION**

The paper presents an analysis of the types of artificial intelligence that are increasingly intertwined with a good business system and make business intelligence.

In the modern business world, many companies become dependent on intelligent systems to quickly and efficiently solve complex problems and even though they are sometimes unaware of it. In order to business successfully and to compete within the great number of companies, it is necessary to respond quickly and adequately. In these cases, they can be assisted by decision-making software that makes decisions based on past successful decisions.

The paper emphasizes the importance of applying business intelligence and ontological structures to the logistics segment, because the application of advanced technology solutions shows significant results in this part of the business. They manifest as safer, more accurate, cheaper and more quality organization of goods transport with a greater connection between manufacturers and logistics centers, which today take on a large part of their business with quality assurance. They have profound effect to the organization of the warehouse, in particular in the function of more efficient utilization of warehouse space, acceleration of operations in warehouse in particular of flow of the reserves and their reduction, reduction of labor costs, increased delivery accuracy and finally greater satisfaction of customers and services provided.

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## ADDITIVE MANUFACTURING TECHNOLOGIES ADOPTION IN AUTOMOTIVE SUPPLY CHAINS – THE THEORETICAL REVIEW

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#### Abstract

In a highly competitive environment, manufacturers are looking for ways to shorten supply chains in order to eliminate shipping costs and shorten production cycles. Enabling the production of individually customized products, which was impossible until now, additive manufacturing technologies caused the revolution in product development and the supply chain structures in various industries. There are two areas in which the additive manufacturing technologies have the greatest impact on the competition in the automotive supply chain: (1) as a source of product innovation, and (2) as a driver of supply chain restructuring. Regarding issues related to the scope of additive manufacturing technologies adoption in supply chains, previous studies were mainly based on an examination of the technical characteristics and advantages of using additive manufacturing technologies. By reviewing and the analysis of scientific and technical literature, available published research results and respecting the paper objectives and the purpose, this paper will explore the impact of additive manufacturing technologies adoption in the automotive supply chain. Specifically, the paper aims to explore the influence of additive manufacturing technologies adoption on lean and agile concepts of supply chain management in the automotive industry.

**Key words:** additive manufacturing technologies, supply chain management, automotive industry, automotive supply chain

#### **1. INTRODUCTION**

The development of additive manufacturing technologies and their adoption in the production processes started to affect the supply chain management in manufacturing sectors of many industries, including the automotive industry (Reeves, 2013). The use of additive manufacturing technologies has the potential to reduce the phases of the traditional supply chains; production can be moved closer to the final customer, and the net effect would be shortening of the supply chain due to reduction in the storing large amounts of finished products. Then, increasing competition strengthens the pressure to reduce the time-to-market - in this context the automotive industry can derive great benefits from the additive manufacturing technologies adoption in the production processes.

The automotive industry accepted the mass production as a standard production strategy (Zhang & Chen, 2006, p. 668). Traditional mass production relies on the ability of companies to accurately predict demand, which in turn affects the decisions on operations and production. However, with the changing demands of the final customers and the transition to mass customization, production based on forecasts may no longer be able to cope with the rapid market changes (Zhang & Chen, 2006, p. 668). Pires and Cardoza (2007) point out that todays` manufacturers are faced with the following challenges: strong pressures to reduce cost and delivery times; improving the quality and overall customer service and the production of environmentally friendly products; a significant reduction in product life cycle and the rapid introduction of new products, with strong pressure to reduce the time-to-market and cost of product development; pressure on the supply of new markets; strengthening and intensifying communication channels in the supply chain. This means that automotive producers need to be flexible and respond to customer requirements in order to succeed in the modern market.

Previous studies determined the importance of efficient supply chain management, but not in the context of the additive manufacturing technologies adoption. One explanation of this research gap is the perception among researchers that the additive manufacturing technologies are not ready for the commercial application yet. In order to define how the additive manufacturing technologies adoption in production processes affect the company's business in the modern competitive environment, it is necessary to observe the problem in a broader context of the supply chain. Therefore, it can be concluded that the study of the impact of additive manufacturing technologies adoption in the context of supply chain is timely and feasible.

This paper will analyze the current scope of additive manufacturing technologies adoption in the automotive supply chain context, in order to meet the requirements of customers. More precisely, the paper aims to explore the influence of additive manufacturing technologies adoption on lean and agile concepts of supply chain management in the automotive industry. Also, the current challenges and perspectives of additive manufacturing technologies adoption in the automotive supply chain will be defined.

#### 2. SUPPLY CHAIN MANAGEMENT IN THE MOTOR VEHICLE INDUSTRY

In a complex automotive supply chain, companies established a tiered supply chain based on degrees, in order to reduce the number of companies directly associated with original equipment manufacturers and their assembly plants. By following this type of supply chain management more responsibility is forced upon the first level of suppliers that can be more easily and effectively managed (Vonderembse & Dobrzykowski, 2013, p. 3). A typical automotive supply chain includes product components suppliers (levels 1-3), original automobile manufacturers (OEM), distributers and retail representatives (dealers). Geographical dispersion of suppliers also has an influence on the time necessary to deliver the parts (it differentiates form supplier to supplier). The hierarchical network of suppliers can be divided into three levels (Leškova & Kovačova, 2012, p. 97):

- Tier-one suppliers manufacturers with their own facilities for production or assembly plants, near to the original equipment manufacturers (OEM), involved in product development and process innovation;
- Tier-two suppliers manufacturers with their own production facilities, producing for tier-one suppliers;
- Tier-three or Sub-tier suppliers raw materials manufacturers with their own production facilities for simpler product components, corresponding to the requirements of tier-two suppliers.

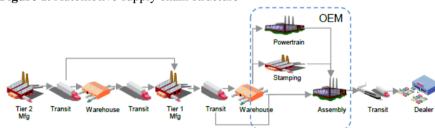


Figure 1. Automotive supply chain structure

Source: Thomas, K. (2012). *The Automotive Supply Chain in the New Normal: Analysis of the Industry and Its Supply Chain Opportunities* [available at: <u>http://blog.jda.com/automotive-resurgence/</u> access November 28, 2015]

Automotive supply chain consists of Tier-two suppliers, Tier-one suppliers, production facilities (OEM) and retail representatives or dealerships (Figure 1). OEM production facilities are divided into assembly, powertrain and stamping department.

Original equipment manufacturers (OEM) are operating in a strong, complex environment with uncertain global competition. This has an effect on a constant necessity for a cost reduction, production increase and quality improvement at all levels of the supply chain. Therefore, the automotive supply chain turns form the forecast-based production, which results with high levels of stock, to demand-based production in order to respond to real time demands of final users. The priority in a supply chain and the original equipment production network is time-to-market reduction, with higher level of product personalization, efficiency and flexibility of assembly plants. In order to achieve this, OEMs are trying to reduce the number of direct suppliers involved in final product development. Supplier reduction is considered to be a strategic goal manly because of two reasons (Holweg, 2008, p. 26): (1) in order to develop long term relationships (Japanese style), motor vehicle manufacturers are focusing on a few key suppliers; (2) due to increase in the product variations, motor vehicle manufacturers must rely on their suppliers. One of the key roles in automotive supply chain belongs to retail representatives (dealers) as original equipment manufacturer representatives and directly responsible for a product sale. The key factor in Lean supply chain is the retailers' optimal level of stock. Therefore, retailers must have an adequate combination of stocks in order to sale the vehicles from stock. For example, Toyota's sales model is designed so that the high percentage of sale is achieved with relatively low level of suppliers stocks; their goal is to storage 20 percent of all motor vehicle combinations representing 80 percent of sale from a specific market (Iyer et al., 2009, p. 15). One of the retailers' techniques to achieve this goal is to advertise and promote only the models available on stock.

With the rise in business relationship complexity in 21st century, supply chain management represents the new source of competitive advantage (Chopra & Sodhi, 2004; Kopczak & Johnson, 2003; Lee, 2004; Li et al., 2005). Despite the fact that the automotive industry was indeed the main source of strategic thinking in business development and supply chain management in the last century (Murray & Sako, 1999, p. 1), from the use of conveyor belt or development of Lean production principles there have been barely few initiatives lately, such as build-to-order production. It is inevitable to conclude that production process complexity in motor vehicle industry was merely an excuse not to accept innovations.

Because of the product complexity itself, most of automotive OEMs outsource the activities of product design or production and assembly of certain parts to specific suppliers. By concentrating the production of high-tech components to a few market leading suppliers, the original motor vehicle manufacturers are trying to simplify internal process management in the production facilities in order to maximize the cost reduction. Increased product technology complexity, great research and development expenses and constant innovations motivate the suppliers to sell entire design and products circuits, not just certain product parts. While the original motor vehicle manufacturers concentrate on developing the core capabilities that enable the necessary differentiation against the competition. According to Gobetto (2014, p. 7), the relationship models between OEMs and their suppliers are structured into different strategic profiles based on the macro-industrial needs:

- a) German model in which local suppliers manage the research and development (R&D) activities, emphasizing the innovation appliance among German automobile manufacturers (for example, strategic innovation alliance between Bosch and Mercedes);
- b) Japanese model in which the OEM represents the first level of innovations and serves as a supply chain support by connecting the suppliers through capital investments (for example, the relationship between Toyota and their supplier Denso);
- c) American model which is commercially more open and oriented towards maximizing economic results in a short term, OEMs are concentrating on market leading suppliers which are taking part in product system development.

While the competition is growing rapidly, the pressure to implement a modular supply system is also increasing, mostly from the OEMs who are seeking more ways to maintain and increase competitive advantage within already overcrowded sector with unstable demand (Collins et al., 1997, p. 498). Carliss et al. (1997, p. 84) describe modularity as a process of developing a complex product combining smaller subsystems that can be independently designed and function together as a whole. In that context, car can be divided into seven main modules (Gneiting & Sommer-Dittrich, 2008, P. 105): (1) frontend module, (2) engine module, (3) greenhouse front, (4) greenhouse rear, (5) rear module, (6) exterior and (7) exhaust module. All these elements should be defined in the final customer order and then connected during the final assembly (Gneiting & Sommer-Dittrich, 2008, p. 105). Advantages created by using this type of approach are smaller number of direct suppliers, lower cost for the OEMs and lower investment risks. On the other hand the advantages for the modular suppliers are increased responsibility, involvement in the development and design of processes and products and the possibility of achieving higher share in activities that create value (Doran, 2004, p. 103).

One of the main reasons why the original motor vehicle manufacturers are transferring to the modular design is a reduced complexity of a final product. This overall approach will not only decrease the costs and complexity of production but also the time needed to develop new products.

Demand for highly differentiated vehicles production combined with the need for increased capacity exploitation, in order to satisfy the market needs, represent the leading drivers of production systems flexibility and product design that allows late configuration. Anyway, upcoming innovations in the field of automotive industry will lead to additional changes in relationship between suppliers and OEMs. In doing so, effective and efficient supply chain will become crucial for the manufacturers and their suppliers.

# **3. ADDITIVE MANUFACTURING TECHNOLOGIES ADOPTION IN THE AUTOMOTIVE SUPPLY CHAIN**

Automobile industry accepted mass production as a standard production strategy (Zhang & Chen, 2006, p. 668). Traditional mass production largely relies on the company's ability to accurately predict demand which has an effect on decision making in business and production. However, with changing customer demand and transition to mass customization, forecast-based production may not be able to cope with the quick market changes anymore. According to Kotler Marketing Group (2009), the original equipment manufacturers are obliged to improve production's style and quality, increase organizational efficiency and import innovative characteristics into their products in order to attract final customers and expand to new markets.

As leaders in modern production development, automotive manufacturers have always been at the top of production technology development. They are also one of the first additive manufacturing technologies adopters, ever since first quick prototype production technologies like Stereolitography hit the market. Contemporary automotive manufacturers use high-tech tools such as Computer Aided Design (CAD) as well as simulation software that reduce production cost with constant improvements in the final product quality. Demands regarding product standardization in automobile industry have become so high that traditional approaches are no longer sufficient. Therefore, the automotive industry had to seek for new advanced and flexible technologies and innovations with Lean characteristics. The key in flexible automotive production strategies is digital engineering adoption including the additive manufacturing technologies.

OEMs work with thousands of different component suppliers and therefore are constantly discovering new ways to shorten the supply chain. With the use of additive manufacturing technologies, original equipment manufacturers are able to rely on internal capabilities and intense cooperation with tier-one suppliers and therefore to maintain or increase research and development share in creating values and production with no need for a complex supply chain management.

Additive manufacturing technologies are shown to be extremely useful to the engineers in product development, the commercial and cargo vehicle production and especially in the production of sport race vehicles with high performances. To this day, additive manufacturing technologies are mostly used in prototyping. However, today's use of additive manufacturing technologies in automobile industry is present in a much significant proportion than just in developing complex onetime prototypes, which are still very important in automobile industry. Additive manufacturing technology advanced applications are more in use in today's production processes, from production of certain parts to final assembly.

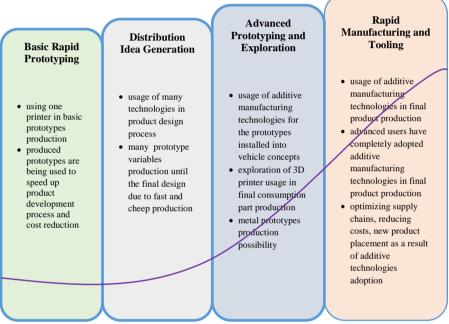
In a Great Britain automotive industry, the use of additive manufacturing technologies is mainly focused on the final product production, prototyping and tooling for high class moto-industry (Feloy et al., 2013, p. 4). Decrease in implementation costs throughout the last ten years has been the key reason for the use of additive manufacturing technologies among commercial vehicle manufacturer's. Also, with significant production process improvement, such as quick CNC technologies, additive manufacturing technologies evolved from fast prototype production technology to fast production technology. Considering new characteristics and possibilities of additive manufacturing technologies, leading automotive OEMs are showing more interest in this field.

General Electric's global research center develops techniques for the production of lightweight structures with additive manufacturing technologies for metal materials, that current manufacturing processes are not possible to produce (GE Works, 2012). Also, Carbon3D American start-up form California, started to produce polymer parts for BMW Group and Ford and is already announcing the production in large series (up to 50 000 pieces per year) with the use of additive manufacturing technologies in the near future.

Gobetto (2014, p. 24) indicated the main additive manufacturing technologies processes used in a production of certain mechanical parts as well as in assembly of operational systems, bodies and finished vehicles: (1) Thin laminated steel and aluminum parts printing by using the process of shearing machining, printing and assembly in a press machine; (2) Printing plastic parts by injection printing, injection compression, extruding and the process of coating and joining parts. These technological areas are linked to all supply chain stages and require specific product design investments from all the supply chain members, not only OEMs as it is usually predicted.

Figure 2 shows the additive manufacturing technologies adoption development model in automotive industry context (SmarTech Markets Publishing, 2015). In the first phase, companies used 3D printers to produce specific prototypes. A large portion of motor vehicle manufacturers entered the first phase of additive manufacturing technologies adoption ten years ago and some remained there until today. Alternatively, users in this phase very often used services of specialized companies for 3D prototype printing.

**Figure 2.** Development model of additive manufacturing technologies adoption in the automotive industry



Source: adapted from SmarTech Markets Publishing (2015). Additive Automotive: Advancing 3D Printing Adoption in the Automotive Industry [available at: https://www.smartechpublishing.com/reports/additive-manufacturing-opportunities-in-the-automotive-industry-a-ten-year access December 12, 2015]

In the second phase, users have expanded additive manufacturing technologies fleet in order to expand the prototype production activities on the production of final parts which cannot be produced by other production methods. In this phase, users are adopting greater 3D technology printing capacities in designing new parts, manual prototype production and the final product processing. In the third phase of additive manufacturing technologies adoption, companies use their own 3D printers and other forms of additive manufacturing technologies for functional prototypes production that will be installed into vehicle model concepts. Besides using 3D printing technologies to optimize product development and design, users apply additive manufacturing technologies in other business production areas (for maintenance and repair, tooling). Final phase of additive manufacturing technologies adoption implies the appliance of technologies in quick tooling as well as in final products production (SmarTech Markets Publishing, 2014). In this phase, additive manufacturing technologies adoption can help in final parts production through molding and tooling, while the most advanced adopters use these technologies for the final parts production. Also, all the improvement categories as a result of additive manufacturing technologies adoption are considered, including supply chain optimization, cost reduction and time to redesign existing and to produce new components.

Additive manufacturing technologies have become a standard practice in contemporary production and product development. In a BMW assembly plant in Regensburg, Fused Deposition Modeling (FDM) technology is still important component in vehicle prototype design. However, in the last few years BMW has expended the usage of FDM technology to other fields and functions including direct digital production (Schmid, 2013). Whereas the use of additive manufacturing technologies enables the production of complex geometrical shapes, they can also significantly increase the efficiency of tool designers and improve manipulative characteristics. FDM production process is very suitable for a complex part production and is growing in importance as an alternative method for complex components production in small quantities.

## **3.1.** The influence of additive manufacturing technologies adoption on lean and agile concept of supply chain management in the automotive industry

An ongoing academic discussion on how to achieve the speed of response to the customer requirements in the supply chain is all about the Lean, agile and Leagile concepts (Christopher, 2000; Christopher & Towill, 2001; Mason-Jones et al., 2000).

The goal of the Lean philosophy is to achieve zero value of waste, and as for the supply chain integration, Lean paradigm goes much further than any other approach in order to set up connections between companies and thereby to integrate suppliers and customers through Kanban or other allocation systems. The center of Lean philosophy is the focus on reducing the time to market. MacDuffie et al. (1996) pointed out that, for the automotive industry, Lean plants are capable of producing more complex products in short series, which potentially gives them the advantage of faster response to changes in the customers' demands. As a reaction to the rigidity of the timetable in the Lean production, agile production approach appeared which promotes two main concepts to achieve flexibility (Kidd, 1994): postponement of decisions on production and product late configuration, in order to respond to customer demands by assembling products to order.

Characteristics of Lean and agile supply chain meet in the decoupling point, which plays the key role in the supply chain and separates Lean and agile parts of the supply chain model (Christopher, 2005, p. 120). Figure 3 illustrates the adoption of Lean and agile strategies in the automotive supply chain, where the implementation was mainly focused on the production until now. In that way, the productivity and goals quality inside the plant are set out at the expense of the value perceived by the customer (Holweg, 2002a: 65).

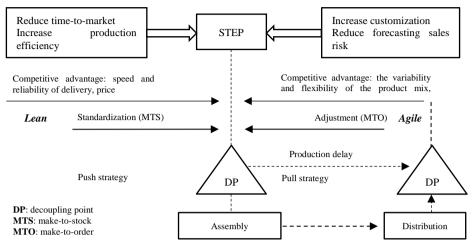


Figure 3. Lean and agile strategy in the automotive supply chain

Source: adapted from Ambe, I.M. & Badamhorst–Weiss, J.A. (2010). Strategic Supply chain framework for the automotive industry. *African Journal of Business Management*, 4(10), p. 2118.

This method of implementing the Lean production strategy resulted in localized optimization where unnecessary seconds are eliminated from the production, while the factory overproduces a two-month vehicle supply for the market. So, in order to avoid negative consequences of using only one of the production strategies, Fisher (1997) suggests the use of all three approaches in combination.

The Manufacturing 21st century report defines nine key challenges for the automotive industry in order to transfer from the make-to-stock and sell-from-stock model to build-to-order model (Holweg, 2002, p. 183-184): (1) dependence of industry on economies of scale, (2) creating a system of producing vehicles in low volumes at reasonable cost, (3) quick delivery of vehicles with custom features – within three days after the order, (4) additional reduce in production volume, (5) enabling the configuration of same components in different ways, (6) stimulate workers, (7) processing the customer participating in order fulfilment, (8) to create an ordering system that will instantly check the combination of customer demands for the security and feasibility of production, (9) managing and controlling big data.

Efficiency in the automotive supply chain can be improved by using the JIT principles, flexible production systems and Lean strategies in supply chain management (Howard et al., 2006), while the effectiveness can be improved through the strategies of quick response and agile supply chain (Perry et al., 1999; Christopher, 2005). In order to secure market share and survival, the supply chains need to satisfy future customer demands. Anticipation of demand is one of the processes which necessarily brings the element of insecurity in the supply chains. However, the accuracy of forecasting can be improved by reengineering the supply chain, especially by reducing the time-to-market (Towill, 1996, p.17), to which additive manufacturing technologies may significantly contribute.

Suri (1999, p. 165) suggests quick response manufacturing (QRM) as an alternative to Lean production, claiming that Lean strategy is not directed to reducing the time-to-market. However, considering that ability of suppliers to quickly respond to market demand is the precondition for the success of the quick response strategy, Fisher et al. (1994, p. 84) question the applicability of the quick response strategy or the JIT concept if the production facility depends on the suppliers who slowly react to market demands. This segment of the Lean strategy offers the possibility to use the opportunity of fast prototyping and final production with additive manufacturing technologies.

Gobetto (2014, p. 49) highlights five contemporary criteria for reducing the timeto-market and assuring the level of quality needed from the first delivery to the customers: (1) conducting various activities at once - simultaneous engineering by involving suppliers into the product design; (2) for the designing CAD programs are used, applying precise predicative analysis; (3) developing specialized tools by using modern CAD techniques together with the process of transformation of materials and simulating prefabricated components; (4) fast prototyping - for that purpose modern tooling techniques are being used (e.g. additive manufacturing technologies) and (5) the pre-manufacturing phase by using finished tools.

Until now, the use of additive manufacturing technologies in the automotive industry mainly contributed to the development and making of prototypes, without using tools and molds which creates the highest financial cost in developing new products. Although it is assumed these technologies will not be widespread in mass production, Rhienhart (in: Sedwck, 2016) points out that by the possibility of producing a product composed of several components, additive manufacturing technologies will significantly reduce production costs and weight of components, which represents the key precondition for sustainable production.

From the perspective of automotive supply chain, advantages of the additive manufacturing technologies adoption in the production processes involve the possibility of introducing Just-in-Time production system in order to reduce stock of semi-products and final products (Dekker et al., 2003, p. 186). Because of its manufacturing possibilities, additive manufacturing technologies are perceived as sustainable production system which can be settled in various links of the supply chain. The additive manufacturing technologies adoption can potentially reduce the phases of traditional supply chain; the production can be moved closer to the final customer, whereas net effect would be shortening of supply chains considering the reduction of the final products storage needed. The product customization is one of the reasons why additive manufacturing technologies will lead to great changes in managing supply chains. A large number of intermediaries, on which today's production depends, will potentially no longer be necessary because of the additive manufacturing technologies adoption.

Additive manufacturing technologies adoption will bring the great savings to producers in terms of the labor costs and potentially in reducing the warehousing, handling and distribution costs of product components. The consequences of additive manufacturing technologies adoption in automotive industry can be massive:

manufacture-to-order strategy could drastically reduce the level of final product stock;

• build-to-order production strategy could substantially affect the manufacturer-retailer relationship - retailers may become "shopwindows" for manufacturers without their own stock.

Many authors envisage the production of spare parts on demand in the near future, practice which significantly affects the need for having final parts stock, accelerates fulfilling the demands of end customers and dramatically affects the supply chains (Holmstrom & Partanen, 2014; Khajavi et al., 2014; Walter et al., 2004). Although additive manufacturing technologies adoption can increase the costs per product unit, by reducing warehousing costs and outdated products, overall supply chain costs could be lower than those in traditional production supply chains. From the supply chain perspective, additive manufacturing technologies also represent the tool suitable for strengthening the flexibility of production systems (Grimm & Wohlers, 2003; Hopkinson & Dickens, 2001).

For agile concept of the supply chain management, the advantages of additive manufacturing technologies adoption are multiple. In agile supply chain it is important that the manufacturers are able to respond to production demand changes fast, whether it is a change in a volume of production or a change in product characteristics (Aliakbari, 2012, p. 47). The use of additive manufacturing technologies reduces the production time because of the possibility of starting the production process right after finishing product design in CAD program. Using traditional methods of producing a new product usually takes several weeks to manufacture the tools needed before final products production can start (Atzeni & Salmi, 2012, p. 1154).

When talking about the additive manufacturing technologies adoption in the production processes, there is no difference between the simple and the complex objects. Unlike the traditional production methods, production of complicated product structures is not more expensive than the production of products with simpler geometrical features. From the perspective of the supply chain management strategy, the product customization gets into the whole new dimension under the low-cost agile strategies category (Nyman & Sarlin, 2013, p. 6). In this case, it is a complete customization, not the massive customization meaning that the product can be completely adjusted to the demands of the final customer without any limitations, whereas the modular structure of product is no longer necessary. Although it has a less direct impact on the supply chain strategies, it can open new possibilities in the product customization to the final customers. Considering the concept of customization by Alfred et al. (2000, p. 100), where the customer is completely involved in the production and the design of vehicles, quick production technologies will have a great impact in the creation of agile supply chains.

Besides affecting the supply chain agility, the ability of producing several various specialized products with one machine also affects the Lean concept of supply chain management through saving and eliminating the need for physical distribution of final products. This concept of production can drastically reduce logistics and production costs. Berman (2012, p. 157) points out that compared to traditional methods, 3D printing technology can reduce the amount of waste by 40 percent in the metal machining. Therefore, from the supply chain strategy perspective, the use of additive manufacturing technologies can potentially have a great impact on total price

of the production and enable complete use of the Lean concept of supply chain management.

Lean paradigm is mostly about the reduction in material waste, the cost and the time for production. Furthermore, in the traditional production methods one of the largest costs for the manufacturers is the tools price. Therefore, in the context of the additive manufacturing technologies adoption in the production process, eliminating the need for tools drastically reduces the overall cost of production. According to Tuck et al. (2007, p. 12), the technologies of quick production will contribute to the Lean methodology in a way that companies will produce spare parts only when needed through JIT technologies for quick production require only 3D CAD data and raw materials to start the production, their use will result in material distribution and warehousing costs reduction for work in progress.

Although automotive industry offers variations in final products (the colour of the body, cover, etc.) this is not the core change category. But, considering the advantages of additive manufacturing technologies adoption, such as the ability of producing complex structures from digital data designed in cooperation with the final customer, core customization of vehicles becomes possible.

Following the above said, it is obvious that the quick production technologies, together with additive manufacturing technologies, are able to produce on final customer demand. With this concept, situations of insufficient or outdated inventories could be avoided, considering that the company is obligated to keep only raw materials on stock (Tuck et al., 2007, p. 15). With the reactive production approach, the use of additive manufacturing technologies reduces time-to- market, which is crucial for both Lean and agile concepts of supply chain management (Nyman & Sarlin, 2013, p. 7).

#### 4. CONCLUSION

Based on the available literature in the field of additive manufacturing technologies, automotive industry, supply chain management and related factors in the field of logistics management, this paper analyzed the influence of additive manufacturing technologies adoption on lean and agile concepts of supply chain management in the automotive industry.

Considering the objectives defined in the introductory part of the paper, the following can be stated: the first paper objective was achieved by in-depth analysis of existing scientific research and actual contributions in the field of additive manufacturing technologies and different dimensions of the supply chain management, with special emphasis on the automotive supply chain; the second paper objective was achieved by the critical analysis of theoretical approaches in analyzing the impact of additive manufacturing technologies adoption in the automotive supply chain management. Therefore, the conclusion is that the objectives of this paper have been fully achieved.

In addition to the systematic and comprehensive review of the domestic and foreign literature and critical analysis of previous research in the field of additive manufacturing technologies adoption in the supply chain, the contribution of this paper is in fact that this is the first comprehensive study of additive manufacturing technologies adoption in the automotive industry and automotive supply chain management, as one of the fastest growing industries in additive manufacturing technologies adoption. Additive manufacturing technologies have potential to significantly affect modern businesses, especially in terms of the potential implications to supply chain management. Therefore, future research should consider the effect of additive manufacturing technologies adoption on the supply chain management dimensions such as supply chain integration, supply chain flexibility or supply chain performance. In this context, quantitative research is suggested.

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## **VII. MARITIME LOGISTICS**

# INNOVATIVE SYSTEM OF TRUCK PRE-NOTIFICATION AT BALTIC DEEPWATER CONTAINER TERMINAL IN GDANSK

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#### Abstract

The problem of innovations in logistics, although not new, is very important and still actual, because it stimulates all the activities, theoretical as well as practical, focused on finding and implementing better solutions than they were before. It should be stated, that examples of innovations in logistics are taking place every day, on smaller or grater scale, even if not formally reported. Thus, it is valuable to identify them for practical and scientific purposes. One of such examples is the case of the Deepwater Container Terminal located at Gdansk. This huge land & see container logistics hub, which is the biggest Baltic container port (1,3 mln TEU in 2016), was facing a lot of logistics problems, mainly of coordination aspect, regarding the service of incoming trucks, causing great time and money loss. In response to these problems, an original truck pre-notification system was invented and applied, which has been resulting in improving the level of services offered by the terminal. However, the results of implementing this system into the terminal logistics operations have not been evaluated yet. This practical reason implies to make a scientific research focused on identification and assessment the system to disseminate knowledge and apply to other cases if possible. Therefore, the aim of this article is to analyse the system of truck pre-notification at Deepwater Container Terminal in Gdansk for the above mentioned reasons and purposes. To meet this aim the "case study" method is taken. Obtained results show that the implemented system of truck booking can be found as innovative, but in comparison to the situation before the system was implemented at DCT Gdansk, and to the other terminals, which have not applied it yet.

Key words: logistics, innovations, container terminal

#### 1. INTRODUCTION

Deepwater Container Terminal located at Gdansk is an intermodal container hub located at the Baltic Sea. As a lot of other business organisations it suffers some logistics problems. One of them are problems of coordination aspect in relation to trucking companies, drivers and forwarders, who wish to deliver or take their containers from the terminal as soon as possible, what results, if not coordinated, in a congestion causing great time and money loss as well as a disorder for the terminal operations. In response to these problems, an truck pre-notification system was invented and applied, which was planned to reduce the problem of long truck queue before the terminal gate. However, the results of implementing this system into the terminal logistics operations have not been evaluated yet. This practical reason implies to make a scientific research focused on identification and assessment the system to disseminate knowledge and apply to other cases if possible. Therefore, the aim of this article is to analyse the system of truck pre-notification at Deepwater Container Terminal in Gdansk for the above mentioned reasons and purposes. To meet this aim first the literature review and then the "case study" method is taken, based mainly on a company data sheet. The results of the case study are included at two chapters. First of them presents main characteristics of Deepwater Container Terminal in Gdansk according to selected perspectives. One of them is a problem of trucks coordination resulting at their congestion. It gives a right background for the next part of the research on the truck pre-notification system at the second chapter, where the specification of functionalities of the system with discussion on the innovation are included.

#### 2. LITERATURE REVIEW ON THE PROBLEM OF TRUCK PRE-NOTIFICATION SYSTEMS IN TERMINALS

The conducted literature study resulted at the following list of problems regarding a truck pre-notification system, namely a problem with:

- terminology,

- methodology of designing,

- methodology of assessment of benefits, influence, innovativeness.

Regarding the problem of terminology some other names are used for the "system of truck pre-notification", which is used at this article, as for instance:

- truck appointment system (Zehendner & Feillet, 2014, p. 461),

- truck queuing system (Chen & Yang, 2014, p. 614),

- vehicle booking system (e.GATE, 2016).

At the literature, there is also diversity on definition of truck pre-notification system. As the above mentioned names used for these systems indicate that they are usually defined by their main function as appoint, queuing, or book. However, some other terms are used as: allocate, limit, control, schedule, reserve, arrange, manage. An example is a definition of these systems as "...systems to limit the number of trucks admitted per time slot in order to even out the demand over the day" (Zehendner & Feillet, 2014, p. 462). This definition is worth quoting, because it also indicates the main reason to introduce an application of such systems. Namely, if the demand, at the sense of trucks in numbers and time slots mainly, exceeds terminal capabilities, there is a need to develop and implement an application to regulate a truck flow, otherwise the terminal suffers congestion problems resulting at an organisation disorder, unnecessary diesel engine exhaust emissions, loss of time and money, occupation of parking lots by trucks, or even drivers' protests. At that context, the system can be perceived as a kind of trucks' regulatory tool, which in administration way controls demand (including cancellation policy), what also means on the other hand, that there is a point of a "bottle neck" at the terminal, in the sense of insufficient staff. material. financial or information resources.

A special part of the studied literature are publications, which are focused on methods and tools for designing truck pre-notification systems. Especially, there are used two main methods: mathematical formulations (Phan & Kim, 2016, p. 42-49; Zehendner & Feillet, 2014, p. 462-468), or computer simulation (Sharif et al., 2011, p. 83-88; Karafa, 2012, p. 43). In reference to the methodology tools for designing truck pre-notification systems, a computer model is preferred (Sharif et al., 2011, p. 83; Chen & Yang, 2014, p. 615-616). An example of a simulation model of a truck queuing system at container terminal of Tianjin Port (China) is presented on the Figure 1.



Figure 1. 3D snapshot of the queue simulation at a terminal gate in PARAMICS software

The above cited example of the gate queue simulation system at Tianjin container terminal is one of many other examples, which present that the main method to assess benefits or influence of a truck pre-notification system is a case study. For instance, P. Dougherty (2010, p. 29) evaluated the impact of a truck appointment system at the Port Newark/Elizabeth marine terminals, and Zehendner, E. & Feillet, D. (2014, p. 467) estimated operations at the Grand Port Maritime de Marseille terminal without an appointment system and with a truck appointment system. In result, this paper was also decided to be a case study, this time on the Baltic Deepwater Container Terminal in Gdansk.

# 3. MAIN CHCARACTERISTICS OF THE BALTIC DEPWATER CONTAINER TERMINAL IN GDANSK

Deepwater Container Terminal in Gdansk (Poland) (shorter - DCT Gdansk) is the biggest Baltic container port (1,3 mln TEU in 2016), which can be classified as a multimodal node (Grzelakowski & Matczak, 2015, p. 28), that integrates three

Source: Chen & Yang, 2014, p. 615

transportation modes, i.e. maritime, rail and road, into a modern logistics hub. Its main characteristics are described from the following points of view or aspects:

- legal status,
- logistics network location,
- offered services,
- KPI (key performance indicators),
- problems.

From the legal point of view, DCT Gdansk is a stock-joint company, but not listed at Warsaw Stock Exchange, registered at the National Court, Department of Business Affairs, under the identification no. 0000031077 on 27 July 2001, while the terminal operations were started in full on 1 June 2007. The equity capital amounts at 67 mln Polish zloty (about 15.5 mln Euro) and consists of 6700 shares valued 1000 zł each. Regarding the structure of owners, it has to be noticed that the majority shareholder is not a Polish capital unfortunately, but one of the world's largest investment fund named Macquarie Group, based in Australia. According to the Court Registry the company is allowed to run the activities as follows: cargo transhipment (handling) in seaports and other reloading places, warehousing and storage, service activities supporting land and maritime transportation, rental and management of own or leased property, auxiliary activities related to property security, wireless telecommunications activities, excluding satellite telecommunications, learning foreign languages, extracurricular forms of education in driving and pilot. Probably, the last two activities requires some explanation, namely the company offers foreign language courses (mainly in English) and carries out training courses to get terminal equipment driving or pilot licences by employees.



#### Figure 2. Location of DCT Gdansk

Source: DCT portal [available at http://dctgdansk.pl, access May 12, 2017]

DCT is located at the north of Poland by the Gulf of Gdańsk at the Baltic Sea with the GPS coordinates of latitude: 54.382563 and longitude: 18.711337 (Figure 2). This company is located on 76,2 ha of the coast in compliance with the norm of ISO 14001 on environment protection. There are two core trans-European transport network (TEN-T) corridors crossing Poland (Figure 3):

- Baltic-Adriatic,
- North Sea-Baltic.

DCT is a node of the first one, which links the Polish ports Gdansk/Gdynia, and Szczecin/Swinoujscie, via Czech Republic or Slovakia and through eastern Austria to the Slovenian port of Koper and to the Italian ports of Trieste, Venice and Ravenna. This corridor includes ports, rail, road, airports, and rail-road terminals. Despite the company is not located directly within the second corridor linking the North Sea ports (Amsterdam, Antwerp, Rotterdam, Hamburg) with the Baltic countries' ports (Klaipeda, Ventspils, Riga and Tallinn as well as Helsinki), it has a good connection via highway A1 (140 km/h), two rail lines and airports in Gdansk and Warsaw. The inland waterway by Vistula River is also planned to modernise to serve a transportation of containers between Gdansk and Warsaw<sup>1</sup>. In broader context, DCT is a part of global supply chains. A good example is the



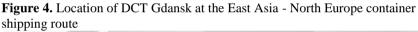
Figure 3. Location of DCT Gdansk at the TEN-T corridors

Source: European Commission Portal. Mobility and Transport. Maps [available at http://ec.europa.eu/transport/sites/transport/files/ten-t-country-fiches/ten-t-country-fiches-pl\_pl.pdf, access May 12, 2017]

<sup>&</sup>lt;sup>1</sup> The first promotional cruise by a barge loaded with containers was held in April this year. See: Zieliński, P. (2017). Promocyjny rejs barką z Gdańska do Warszawy! (eng. Barge promotional cruise from Gdansk to Warsaw) [available at http://gdansk.naszemiasto.pl/artykul/promocyjny-rejs-barka-z-gdanska-do-warszawy-zdjecia-wideo,4090277,artgal,t,id,tm.html, access May 12, 2017]

East Asia - North Europe container shipping route, serviced by 2M Alliance<sup>2</sup>, which takes the world's greatest market share of about 28% (Rau & Spinler, 2017, p. 156), with DCT in Gdansk as a transhipment or destination port (Figure 4). Another example of the port important place at the global supply chains is of potential meaning. Namely, looking at the map (Figure 5), which illustrates China's conception of "One Belt One Road" corridors, it is relatively easy to formulate a thesis that good transportation connections with the rest of country create a very large potential for DCT to function as a logistics regional centre for goods traded between Poland and China as well as a transhipment point for foreign trade. And last but not least, the DCT location should be mentioned at the aspect of a regional port for feeder relations, mainly to Finnish ports and St. Petersburg (Russia) (Urbanyi-Popiołek & Klopott, 2016, p. 521).

A good location was one of many factors, which DCT used to develop its services to the actual range, which expands from ships services via transhipment or warehousing to educational courses. Speaking more detailed, DCT services can be classified into two groups. The first one contains standard market offers with fixed prices, while additional services, including the ones not specified explicitly, stand for the second group. The list of standard services with their prices is presented at the Table 1. The other services offered by DCT are: cargo unstaffing/staffing at Container Freight Station (CFS), external parking lot, vessel operations or storage space renting.





Source: DCT Gdansk Presentation. January 2017 [available at http://dctgdansk.pl/wp-content/uploads/2013/03/DCT-Gdansk-Presentation.pdf, access April 22, 2017]

<sup>&</sup>lt;sup>2</sup> 2 M Alliance includes two world's largest container carriers, Maersk Line and Mediterranean Shipping Co., which signed a 10-year vessel sharing agreement on the Asia-Europe, Transpacific and Transatlantic routes in July 2014 and launched their operations in January 2015. Source: World Maritime News Portal [available at http://worldmaritimenews.com/archives/149314/2m-alliance-officially-launched, access May 12, 2017]



Figure 5. Location of DCT Gdansk at "One Belt One Road" corridors

Source: Polish-Chinese Cooperation Forum [available at http://chpcf.pl/en/blog/one-belt-one-road, access April 22, 2017]

Regarding the key performance indicators (KPI), two main measures were available. First of them is efficiency of DCT calculated according to DEA method of relative productivity evaluation. This indicator value is 100% in 2016 (Wiśnicki & Chybowski & Czarnecki, 2017, p. 13). Interpretation of this value can be quite different, because 100% can indicate very good efficiency if all the resources are utilised in full, but on the other hand, it can be stated that there are no reserves, or no safety margin for instance for unexpected grow in demand or equipment failure, what means the resources can limit DCT Gdansk activities and stand for a bottle neck. The second indicator is the turnover of TEU, which is presented at the Figure 6. A quick analysis of this measure allows to claim that there is a steady growth at the container operations.

Despite of good business position, DCT suffers some problems. Of course, there are so called constant problems regarding market competition, changing political, economical, technical and socio-environmental, but these kinds of troubles touches all business organisations, and methods of managing them are known, generally. However there are some specific problems touching intermodal hubs. Because it is just intermodal hub, the main problem is integration of different transportation modes with handling and warehousing operations on containers. Speaking more detailed, for a long time DCT could not manage the problem of truck congestion caused by not synchronised notification about containers to pick up or drop off. In results some dramatic scenes could be observed, where truck drivers

Table 1. Thee list of Del standard services							
Service name	20'	40'	% of surcharge to the basic rate				
			Sat	Sun	Holi day	Non- ISO	IMO 1-5
Unloading/loading full ISO container in ship's hold via ship's rail to yard or truck/wagon relation or vice versa	€97	€112	50%	100%	150%	75%	100%
Unloading/loading empty ISO container in ship's hold via ship's rail to yard or truck/wagon relation or vice versa	€90	€100	50%	100%	150%	-	-
Reefer container's power supply and monitoring (for started calendar day)	€25	€25	-	-	-	-	-
Reefer container's Plug in or plug out on yard (per 2 actions)	€18	€18	50%	100%	150%	-	100%
Full containers' storage in export/import (per calendar day per container) for the first 5 days	-	-	-	-	-	-	-
Full containers' storage in export/import (per calendar day per container) for the day 6 - day 14	€3,80	€7,60	-	-	-	-	100%
Full containers' storage in export/import (per calendar day per container) for the day 15 - day 30	€5	€10	-	-	-	-	100%
Empty containers' storage in export/import (per calendar day per container) for the first 5 days	-	-	-	-	-	-	-
Empty containers' storage in export/import (per calendar day per container) for the day 6 - day 14	€1,10	€2,20	-	-	-	-	100%
Empty containers' storage in export/import (per calendar day per container) for the day 15 - day 30	€1,30	€2,60	-	-	-	-	100%
Container manipulation on yard	€60	€65	50%	100%	150%	75%	100%
Container inspection with cargo turn out	€16/t	€16/t	50%	100%	150%	-	100%
Railway service manipulation fee (per TEU)	€3,50	€3,50	-	-	-	-	-
Issuing R-25 and R-27 rail wagon hand over documentation (per wagon)	€7,10	€7,10	-	-	-	-	-
Issuing railway bills (per container)	€1,50	€1,50	-	-	-	-	-
Train staying at rail siding (per train/hour)	€80	€80	-	-	-	-	-
	1						·,

#### **Table 1.** Price list of DCT standard services

Source: Standard Tariff DCT Gdańsk 2017. [available at http://dctgdansk.pl/upload/files/ standard-tariff-dct-gdansk-2017-.pdf, access April 22, 2017]

were protested against huge queue, and loss of time and money. This abnormal situation led the DCT managerial board to develop and implement a pre-notification system at the form of computer and internet application. Despite the system is relatively new, because it started as an obligatory application on 20 March 2017, its functionalities and users opinions can be researched to answer if it is innovative or not.

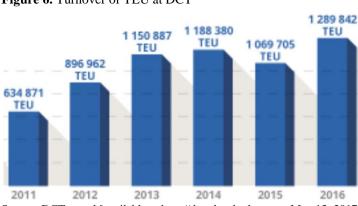


Figure 6. Turnover of TEU at DCT

Source: DCT portal [available at http://dctgdansk.pl, access May 12, 2017]

#### 4. ANALYSIS OF TRUCK PRE-NOTIFICATION SYSTEM AT DCT **GDANSK**

DCT Gdansk uses an information system "NAVIS" to manage its operations. One of modules of Navis is a truck pre-notification system called "e.GATE", which was introduces to daily operations on March 20, 2017. It is dedicated to drivers, transportation companies and forwarders to plan truck visits to DCT Gdansk, effectively. It is optimised for mobile devices as smartfones or tablets. This system allows the above mentioned users to decide when they would like to pick up or drop off full containers (the system does not concern about the empty ones). After choosing a suitable time slot, what is possible by logging into the e.GATE system, a driver creates an appointment and declares his or her arrival in the chosen time frame. Before implementing e.GATE (e.GATE, 2016):

- 15 meetings were organised for the future users to learn the system in May 2016,

- 10 external training sessions were hold with 113 attedences, who had been instructed on the system in December 2016

- 382 drivers were trained in internal trainings when visiting the terminal's pre-gate building.

- 25 trucking companies were testing the application with positive results.

Actually, the main functionalities of the system are (e.BRAMA, 2017):

- creating/deleting transportation set (driver, truck, trailer),

- choosing containers,
- linking containers with a transportation set,
- choosing time slot to enter DCT Gdansk,
- sending SMS with a number of visit,
- downloading and printing a confirmation with the number of visit,
- previewing and edition of data.

Some additional characteristics of the system are as follows (Aktualności, 2017):

- 669 trucking companies, 2523 drivers and 2449 transportation sets were registerd on 6 March 2017,

- 73% of all gate transactions were done by e.GATE, the rest of 27% of trucks had to wait about two hours more,

- 69% of time slot utility, of which 63 were used in accordance with the chosen time slot, while 6% - out of the slot.

In edition to these above mentioned functions, drivers opinions on the e.GATE functions have appeared. Some of them are (DCT Gdansk, 2017):

- the system can not offer to choose longer than one hour time slot,

- still lack of time slots at peak hours,

- one hour free parking place is not enough for trucks.

Taking into account all the pro and cons characteristics of e.GATE system it should be stated at the context of innovation that pre-notification or vehicle appointment systems are used on a daily basis by majority of large container ports, which were cited for instance at the literature review chapter. So, in comparison to these ports, the implementation of e.GATE by DCT Gdansk would be difficult to name as innovative. However, on the other side, in comparison to the previous situation at DCT Gdansk, when no such a system of controlling gate transactions was applied, what resulted at operations disorder for trucking companies, forwarders, drivers as well as for DCT, the development of the truck appointement application called e.GATE, should be found as innovative, but with stipulation that only for DCT Gdansk itself or in comparison to the other container terminals, which operate without such a system.

#### 5. CONCLUSION

Final results presents that the above analysed truck pre-notification system at DCT Gdansk called e.GATE is one of many similar sytems, which are to cotroll the truck flow at terminals effectively. There is still a problem of assessing if implementation of such an application can be named as an innovation or not. Regardind the case of e.GATE application, the obtained results indicate that the positive or negative assessment depends on the point of view. So, taking the DCT Gdansk perspective, with no doubt, this system can be treated as innovative, because it enables gate operations to be more effective for all the stakeholders, including mainly DCT Gdansk, truck drivers, truck companies and forwarders. However, there is still a space for the open questions/issues in order to better demonstrate the possibilities for further research directions. Namely, it is suggested to monitor new gate control systems and trends they are evolving for improvement purposes, and at the innovation contex, to elaborate a formaly accepted assessment methodology of innovative applications at the area of transportation, logistics, supply chain and forwarding.

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### THE ROLE AND PLACE OF CUSTOMS IN PORT COMMUNITY SYSTEM - EXPERIENCES FROM POLAND

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#### Abstract

Seaports are natural bottlenecks in the transport chain, yet they are logical places to carry out customs and other services controls. Port Community Systems have played a major role in facilitating the more efficient movement of goods while allowing Customs and other government departments to maintain effective controls. This article concentrates on qualification and assessment of the role and place of Customs Office in the PCS organization. In so doing, the role that such Customs can play in terms of implementing the "Ports 24h" programme. The article presents some of the problems in creating the Polish port community system which has to integrate three Polish seaports: Gdańsk, Gdynia and Szczecin-Świonujście. Unfortunately, there is currently no port community system operating in Polish seaports. There are, however, certain single windows created by the Polish Customs Service, Maritime Administration and Main Container Terminal Operators, and they can be used to develop the PCS. There is a major problem concerning how to use those windows to create the PCS. Moreover, the Polish Customs Service has developed system called the "Ports 24h" programme. The article analyses the role and place the Polish Customs in creating integrated port community systems.

Interviews conducted with prominent representatives of ports' stakeholders has made it possible to evaluate the role of Customs Service and indicate the benefits of adopting the system than just improving speed. Such advantages include more efficient control and supervision (risk analysis), costs reduction and increased competitiveness. All of these initiatives have jointly incentivised some of the former importers to return to Polish seaports; however, the situation is believed to change in the near future.

Key words: port community system, seaports, Customs Office

#### **1. INTRODUCTION**

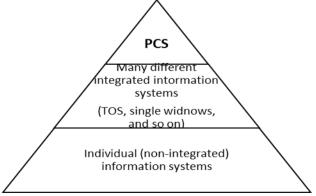
The container growth of the Polish trade, together with the emergence of global sea shipping and terminal operators, has resulted in increased demand for seaports and their related services, divided into competing nodal points in the entire global logistics chain. In an effort to improve their competitive position, in Poland, we have commenced planning, implementing and developing the Polish National Port Community System (PNPCS), which constitutes an electronic platform that connects the multiple systems operated by a variety of organizations making up the seaports

community, and which is believed to be a significant contributing factor to the more efficient movement of cargo across Polish sea borders. Seaports have always been clusters of economic activity. The arrival of vessels and cargo in seaports have always been seen as attractive for same trade participants, such as vessel operators, forwarders, marine and land terminal operators, and other transport and logistics operators. These activities are located in seaports precisely because the main transport nodes are found there. Furthermore, seaports are attractive locations for logistics acts, such as storage, assembling, repacking, consolidating, configuring, countrylizing, quality controlling, customizing, packaging, finishing, merging, testing, barcode labeling, tracking and tracing, and so on. Seaports are also industrial zones. Because of the storage and transport commodities such as: oil, coal, iron ore, grain, containers and pallets units and some production activities, including steel production and chemical products, seaports very often accomodate manufacturing activities. Seaports are additionally centers of seaborne trade. Some commodities - such as steel, grains, oil, timber, chemical, trading - occur in the same places as storage or warehouses because buyers and sellers want to inspect the products, or because forecasting on shipping prices is either increasing or decreasing. In the marine logistics, a crucial question is the issue of integration between the various parties engaged in the supply chain. The Council of Logistics Management, in its definition of supply chain management, includes coordination and collaboration with the channel parties, which can refer to suppliers, intermediates, third-party service providers. The Customs Service is crucial to marine supply chain operators. So, integrating the Customs Service with the remaining participants of marine logistics is essential, and may lead to improved operational and economic performance.

At the beginning, many important participants used to take place in seaborne trade (ocean and feeder ship owners/operators, marine container terminal operators, marine forwarders, port authorities, maritime authorities, depot containers operators, pilots firms, mooring companies, stevedoring companies, customs agents, coast-guard service, Customs Office, chambers of commerce, consignor, consignee, rail (multimodal) transport operators, in-land container terminals operators, truck companies, truckers, veterinary office, fishery office, sanitary office, phytosanitary office, government authorities, inland railway terminals operators, inland shipping companies, port control, shipchandlers and store suppliers companies, fleet management companies, tugs and towing services companies, logistics centers, and so on) used individual (internal) closed information systems. The internal information systems are those employed solely by marine logistics service providers (MLSP) and they do not directly interact with the outside world. Internal information systems are used in a variety of ways to assist the MLSP and their management to track sailings, shipments and equipment inventory, and to monitor financial, operational and market share performances. The systems have not allowed the transfer of data and information among the above-mentioned participants. Therefore, they had to use electronic mail or other communication system to transfer data and information, the so-called external system. The external information systems are integrated with or are linked to upstream and downstream contact points. These links include upstream suppliers, like truckers, rail operators, marine and in-land container terminals operators, depots operators, and customers such as shippers, Customs Office, custom agencies and other governmental bodies. The external information systems also allow for the electronic interchange of data between the MLSP and its various customers. Moreover, all the participants had to draft paper documents and they had to physically transport them to the consigner. To ship a container, Polish marine forwarders need to know all the systems used by different marine container terminals operators. In Poland, there are three main seaports, i.e. Gdynia, Gdańsk (located in Gdańsk Bay, on the southern Baltic) and the port complex Szczecin-Świnoujście situated in the western part of Poland's coastal area. The Gdvnia seaport has agreements three marine container terminals operators: Baltic Container Terminal Ltd. (belonging to ICTSI – International Container Terminal Services Inc. - Manila), Gdynia Container Terminal Inc. (belonging to Hutchinson Port Holding – Hong Kong) and OT Logistics Group Inc. (belonging to Polish Capital – with a diversified commodity portfolio – included container operations). The Port of Gdańsk included the following container terminals: Deepwater Container Terminal Inc. (owned by The Macquarie Pension Funds), Gdansk Container Terminal Inc. (owned by Gdansk Port Authority). The port complex Szczecin-Świnoujście, meanwhile, embraces only one container terminal, and that is OT Port Świonujście Inc. (owned by OT Logistic Group). The Polish container operations are increasing rapidly. Every year, we observe a growing container turnover, and investing in new stores, warehouses, trucks, intermodal equipment's, and finally new and sophisticated information systems.

For that reason, the Polish National Port Community System must be created in Poland. The creation of a port community system (Figure 1) should consist of three stages: (1) individual (non-integrated) information systems; (2) many different integrated information systems (TOS, single windows and so on); and (3) port community system. For the purpose of this paper, the author does not limit the scope to one Polish port community system, but opts for the Polish National Port Community System that could apply to all the three main Polish seaports.

Figure 1: Port community system creation stages



Source: Own elaboration

Currently, some participants of seaport activities are developing their own integrated information systems – "micro-pcs". Such "micro-pcs" have been constructed by the Polish Custom Service (the "Ports 24h" programme, one-stop-shop

platform and single window), Maritime Authority (SWIBŻ system) and Marine Container Terminals Operators (Terminal Operating System – TOS). These systems allow to transfer data and information among dedicated customers. Such sophisticated integrated systems provide the foundation for the Polish National Port Community System, in which all logistics service providers will use one integrated electronic platform for three main Polish seaports mentioned above.

### 2. METHODOLOGY

In the face of greater competition, managers of seaports have to take advantage of the seaport community system offers. Creating and developing an efficient and integrated port community system for the entire seaport community is one of the ways that managers of seaports can meet the demands of the new situation. Establishing a general PCS frame is therefore of great interest.

An empirical study on depth personal interviews addressed to customers, officers, maritime authorities officers, seaport employees, and other seaport community managers. These surveys were then used to evaluate how the Polish National Port Community System should be developed. Basically descriptive in approach, the research was designed to provide a clear picture of the PCS. It was also conceived as an exploratory report, using a series of open questions to obtain managers' opinions on the system to be used in the future and the risks it entailed.

It is also a co-relational study employing a hypothetical, deductive methodology seeking to identify relations between PCS and SW. The principal component analysis was used to identify Customs' data and information which could be used in the PNPCS. The main idea was that the study could be followed up by similar reports in the future to analyze the way the main areas studied here have developed. However, this review is qualitative and limited to the three main Polish seaports communities (Gdynia, Gdańsk and Szczecin-Świnoujście).

The study is subject to a number of limitations. First, the analysis has not covered other highly important areas of the PNPCS development, among them: legal framework, its interfaces and technologies, its detailed of offering services and methods of financing, and so on. Second, the analysis focused mainly on the Customs Office level and therefore it did not take into account the role of the other participants of the PNPCS acting in seaports communities. Future research could address these issues, especially interactions and co-operation at public and private business unit level within seaport communities and between seaports in these electronic platform networks. In addition, future research could extend the analysis to cooperation of the public and private business units after the PCS is implemented and how the Customs' role will be helping in seaports and trade.

### **3. LITERATURE SURVEY**

Literature review revealed there was a wide range of PCS setups and each had its own characteristics. Perusal of the literature shows that existing research embraces five scientific areas, namely: (1) description of PCS (Srour et al., 2008; Rodon & Ramis-Pujol, 2006; Durán & Córdova, 2014, pp. 35-44; GIL, 2012, Marek, 2016, pp. 35-50). These descriptions focus on the general benefits offered by each electronic platform, the functionalities that they provide and under which type of port governance they are applied. However, little attention was paid to revealing the exact benefits that each type of PCS users (e.g. marine terminal operators, carriers, marine forwarders, ship operators) benefits from after joining such platform, or even less to quantifying these advantages. PCS users are logistics stakeholders seeking to improve their productivity and/or reduce their costs through sharing data; (2) cooperation amongst logistics stakeholders often refers either to vertical integration or to horizontal collaboration of actors (Van de Voorde & Vanelslander, 2014; Leitner, 2011, pp. 332-337; Wang, 2014, pp. 253-257; Cruiissen et al., 2007, pp.129-142; Leitner et al., 2011, pp. 332-337; Keceli et al., 2011, pp. 151-167). These collaboration studies demonstrate particular benefits gained by each actor who has joined the electronic platform. Moreover, results of their studies show that PCS integrates both types of cooperation - vertical and horizontal - and therefore their cumulated range of benefits for all actors operating within the port community system; (3) PCS design and functionality (Rodon & Ramis-Pujol, 2006; PORTEL, 2009; EPCSA, 2011; van Oosterhout et al., 2007; Keceli, 2011, pp. 151-167; Durán & Córdova, 2014, pp. 191-208; Srour et al., 2008; Verhoeven, 2010, pp.247-270; Van de Voorde, Meersman & Vanelslander, 2011, pp. 822-843; Heaver et al., 2001, pp. 293-305). The studies referred to PCS functionalities or application modules when presenting the PCS platforms. According to the authors, PCSs are individual electronic platform developments that incorporate different functionalities of one specific port. Furthermore, these functionalities are being supported by applications of different modules which deal with more specific tasks. A PCS has therefore a multilayer structure characterized by different functionalities that are put into practice through a set of separate modules. The stakeholders involved in the port activity (whether they are private shareholders, customs officers or port authority) can either make use of all the functionalities of the PCS, or only some part of them, as well as make use of individual modules only. Moreover, results of their studies directly indicate that all PCSs are modular; (4) costs of PCS (Southon et al., 1999, pp.33-46; Baalen & Beije, 1998; De la Guia, 2013; Sweeney & Evangelista, 2006, pp. 27-43; Miranda, 2003; Tijan, 2009, pp. 557-568; Tijan et al., 2009, pp. 305-315). These studies note that the term cost goes beyond its financial meaning, and it can refer to the barriers that need to be overcome so that the collaboration relations between port stakeholders can be established; (5) PCS benefits (Cuadro & Cervera, 2004, pp. 320-330; van Oosterhout et al., 2007; Cordova & Duran, 2014, pp. 191-208; Mila, 2007; Gustafsson, 2007, pp. 14-20; Durán & Córdova, 2012, pp. 35-44; Keceli, 2011, pp. 151-167; Keceli et al., 2008; Avdogdu & Aksov, 2013, pp. 1-10; OECD, 2012; Srout et al., 2007; Cišic et al., 2009, pp. 3; De la Guia, 2013). Results of the scientific studies may be divided into the following categories: economic benefits, increase quality of information, increase performance, increase competitiveness and increase efficiency (Carlan et al., 2015). These criteria should be taken into consideration by the port authorities in order to improve the competitiveness of a particular seaport.

These researches do not concentrate on the role and place of Customs Office in port community system but it should be taken into account by the PCS creators in order to improve the competitiveness of particulars seaports.

# 4. FORMS OF PORT COMMUNITY SYSTEMS IN THE EUROPEAN UNION AND POLAND

Legislation in force and economy forms of port community system are strictly related to the type of local organisation fostering the PCS development in the business-repersented nature of the stakeholders of the PCS managers/supervision company. In that respect, three main types of PCS operators may be identified (MED-PCS, 2013, pp. 19):

- Private.
- Public.
- Mixed public/private (PPP).

The first solution concerns "private stakeholders implementing a bottom-up approach, or in other words, if private operators boost development of the PCS, it would be quite straightforward to expect the same of private stakeholders such as: shipping companies, marine forwarders, shipping agents, sea container terminal operators, stevedore companies, multimodal transport operators, brokers, and so on. Sometimes, private associations of entrepreneurs (e.g. chamber of commerce) and financial institutions (e.g. commercial banks) act as relevant stakeholders" (MED-PCS, 2013, pp. 19).

"The public stakeholder scheme is instead coupled with the top-down implementation approach, which normally envisages the port authorities and possibly other public bodies as main shareholders. In countries with proactive participation of national public authorities (such as Poland currently – there is a trend towards centralisation of economic activity), the presence of state-owned corporations as main stakeholders is also common" (MED-PCS, 2013, pp. 19).

"The mixed public/private scheme is aimed at achieving a full acceptance and/or an active participation of private companies in top-down PCS implementation. In that respect, probably the most advanced and complex scheme of public-private partnership is represented by the SOGET experience in France" (MED-PCS, 2013, pp. 19).

"An interesting analysis can be carried out by comparing the focal organisation and the business model of some PCS implementation" (MED-PCS, 2013, pp. 19), as reported in some remarkable case studies presented in Table 1 below.

Country	Port	Name of	Type of	Name of	Type of	Business
		system	system	focal	focal	model
		•	•	organiz	organiz	
				ation	ation	
France	Le Havre	AP +	PCS +	SOGET	mixed	PPP
			SW	SA		
Germany	Hamburg	Dacosy	PCS +	Dacosy	private	Bottom-
			SW			up
Belgium	Antwerp	Porthus.net	PCS +	Port-I-	mixed	PPP
			SW	Com		
Netherlands	Rotterda	Portbase	PCS +	Portbase	public	Top-
	m		SW			down
Italy	Livorno	TPCS	PCS +	Port	public	Top-
			SW	authority		down
Italy	Venice	LOGis	PCS	Port	public	PPP
				authority		
Italy	Genoa	E-Port	PCS +	Port	public	PPP
			SW	authority		

**Table 1.** Main characteristics of port community systems in the EU.

Source: MED – PCS, 2013, pp.20.

In Poland, there are some discussions regarding business model of the Polish National Port Community System. In these areas, there are two bottom-up initiatives to develop, implement and maintain this electronic platform. One proposition is a private model within which a vehicle purpose company VPC was set up and the project's main financing source was UE funds. That company is called HTPCS (High Technology Port Community System) Ltd. The second initiative has been proposed by the Logistics and Warehouse Institute and Baltic Container Terminal Gdynia Ltd. Unfortunately, the latter solution is not neutral for other stakeholders of the Polish seaports. Anyway, the most important vision on business model of PNPCS should come from the Polish Ministry of Maritime Economy and Inland Navigation. The Polish Ministry should set up a company – a PCS operator. Every Port Authority (Gdvnia, Gdańsk and Szczecin-Świnoujście) should have 33% of shares in the new company. The Polish Ministry of Maritime Economics and Inland Navigation should have a 1% share (Figure 2). The capital structure of the PCS operator is, of course, still being discussed. The Polish Ministry should indicate the leader of the PCS, e.g. the Gdynia Port Authority, who will be responsible for creation, implementation and maintenance of this electronic platform. The leader Port Authority may create a cluster of companies that will be participating in a venture of this calibre.

When creating the Polish National Port Community System in Poland, one should examine organizational aspects such as (IPA, 2014, pp. 69-70):

• "Which governmental authorities and agencies should be involved?

• Which governmental authority/agency, or private organization should lead the running of the PCS - government, private owner under government contract or completely privately-owned by business (service provider)?

• Whether the Port Community System should be centralized or decentralized?

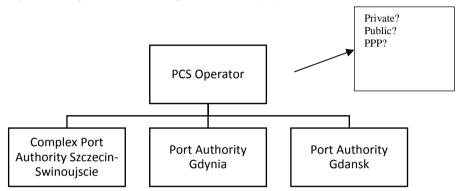
- Should it be an active or passive system?
- Should a payment system be part of the PCS?
- Should participation be voluntary or mandatory?

• Should common risk profiles/compliance assessments be part of the system

and should they be developed and/or shared?

• Who bears the risk if/when something goes wrong?"

Figure 2. Proposed structure of post community system in Poland



Source: own elaboration

The next steps, in turn, which must be taken into account is examining the existing requirements, procedures, and processes for the submission of import, export and transit documents and information. Many of these documents and information have to be standardised for all participants of the PNPCS. The creator of PNPCS, however, must find answers to the following questions (IPA, 2014, pp. 69):

- "Identify key private companies and governmental authorities that can potentially be involved in the system.
- Determine the extent to which it is possible to harmonize and simplify these requirements, procedures, information flows and documents.
- Explore possibilities for ensuring the single submission of documents and information.
- Consider the potential of the Port Community System to address trade security issues.
- Identify the needs of potential users, especially regarding the design of the eventual service and associated interfaces (either electronic or physical).
- Consider "best practice" methods in existing Port Community System. This may involve visits to operational Port Community Systems.
- Consider the need for and approach to generating the required political support for the project".

The description of the PNPCS as any other information system is primarily a tool to increase the present and future efficiency of the organizations directly engaged

in marine container logistics, to utilize their resources more effectively in order to reduce costs and increase profits. Comparing this advanced system with the traditional manner (paper documents) of data collection and processing, the benefits achieved are obvious. The range of data reporting is enlarged and its faster processing is enabled, which translates into more and more actual data and information concerning basic operations on performance being continuously at the disposal of the PNPCS users. Aside from status reports based on e- stock information, which can be easily reduced to essentials, re-grouped etc., special figures can be compiled with a view to forecasting and planning.

The Polish National Port Community System should cover the key functional components and associated constituent data flows reveal the operational aspects of the PCS. The PNPCS should comprise the following functional components: documentation origin, logistics transactions, sensing network, freight risk management, credentials identity, traffic information integration and electronic payment.

However, suggestions to obtain standardized and simplified documents in order to facilitate international trade relations do exist. The PNPCS should mainly rely on the European Union Derivatives' standards methods of data presentation (including codes and formats), but the implementation of these useful documentation procedures will take a couple of years. Moreover, the replacement of traditional maritime documents in order to promote electronic data exchange by the Polish National Port Community System could prove difficult due to the fact that documents for sea carriage (mainly bill of lading) have the additional status of a negotiable files, thus awarding a legal title to the owned goods.

In the long run, the development of standardized electronic data and information system may lead to the concept of data interchange not only within Polish seaports, but also between trade participants and seaports located all over the world, i.e. electronic data interchange is possible with regard to vessel and cargo movement in the whole container logistics chain.

A modernized Polish National Port Community System should be the key element of logistics chains which go through seaports, where sea transport is directly linked with other modes of transport such as: road, rail and river. Unfortunately, some processes of transshipments, storages, warehouses and controls, as well as some business relations of all stakeholders involved in the PNPCS creation, are becoming increasingly complex since all public and private operators of seaport activities are hard-pressed for lack of time, growing customer expectations, plus increasing costs and commodity quantities.

## 5. ROLE OF CUSTOMS OFFICE IN CARGO EXPORT AND IMPORT

The Polish Customs Service controls and inspections are those exercised over the process of international seaborne trade with relation to specific control over the following areas (Rowbotham, (2007), pp 15):

- "Imports of goods.
- Exports of goods.

- Illicit trade i.e. contrabanding, smuggling.
- Prohibitions and restrictions of the import or export of certain commodities and products.
- Direct (duties) and indirect taxes, and
- Seaborne trade statistics".

The above-mentioned areas of the Customs duties should play an extremely important role in the PCS given the influence on the speed of controls and inspections of all Polish public control services. The export or import of element of Polish Customs Service controls, with regard to maritime movements, has become more automated and electronic along with the implementation of e-customs, although it is still required to submit the full cargo manifest of the Customs Office by the ship's agents prior to the vessel being cleared by Customs for sailing. The cargo manifest involves, however, the issuing a marine bill of lading for each consignment, coupled with the raising of e-customs export and import declarations by the clearing customs agent/freight forwarder. The submission of each set of documents rests with different parties, as the following summary presents (Rowbotham, (2007), pp 15):

- The cargo manifest is submitted to Customs Office by the vessel's agents or the port agents or forwarders.
- The declarations are submitted by the freight agents.
- The bill of lading is raised by the carrier (the shipping line or/and marine container terminal operators).

The bill of lading is submitted by the shipping line to the freight forwarder responsible for the organization of the shipment, and some agreed copies with the parties should also be held by the ship's agent or import container terminal operator who submits the cargo manifest on behalf of the shipping line to the Customs. There are some cases that indirectly indicate who is responsible for loading cargo aboard a vessel, owing to the absence of specific incoterms in the contract of delivery. In this case, the Customs Office is not aware that the consignment has been loaded aboard the vessel, and consequently has not been correctly declared. There are also some problems in the case of hazardous or dangers cargoes which are incorrectly declared for customs (i.e. improper IMO class indicated) could prove disastrous in the event of an accident aboard the vessel or a collision, or another disastrous occurrence (Rowbotham, (2007), pp 15). This is because "a trader, i.e. exporter or importer, could be held liable for the consequences of such accident. Further consequences of a failure to correctly declare a consignment for customs is that the trader is liable for VAT on the value of the consignment and equally a civil penalty on the grounds of a false declaration being made to the Customs Service" (Rowbotham, (2007), pp 15). Unfortunately, traders would like to gain better terms of VAT settlements and that is why they prefer German or Dutch seaports over Polish ones (Montwill, (2011), pp. 859-868). Therefore, the Port of Hamburg in Germany, used to be called the "biggest Polish port" for many years (Klopott, Miklińska (2016), pp.107-114).

The vessel notifies the port of its impending arrival. The cargo manifest (in its electronic UN/EDIFACT CUSAR format; Long (2013), pp. 63-67) is submitted electronically by the port agents representing the shipping line to the Polish Customs computer. The port agents also submit the IMO FAL forms detailing the following information:

- IMO General Declaration (FAL form 1).
- Cargo Declaration (FAL form 2).
- Ship's Stores Declaration (FAL form 3).
- Crew's Effects Declaration (FAL form 4).
- Crew List (FAL form 5).
- Passenger List (FAL form 6).
- Dangerous Goods (FAL form 7).

"Based on this electronically submitted information, a customer officer may decide to travel to the port to board the vessel and examine the details referring to the crew or its passengers" (Rowbotham, (2007), pp 15). One system which has facilitated the electronic submission of the cargo manifest is CELINA, an electronic cargo processing system originally developed by the Polish Customs Service under the maritime cargo processing. This e-customs platform facilities submission of the cargo manifest to the port authorities and the Customs to select in advance those containers which require examination or scrutiny when unloaded from the vessel. The Polish Customs Service, unfortunately, has complained about the lack of necessary data and information on the containers and commodities prior to its arrival into the Polish seaports. Such data and information are highly important for risk assessment as they enable the identification of containers and commodities in transit and traders (importer/exporter) contract. The lack thereof has led to a problem aimed particularly at producing better-targeted customs controls and inspections of containers and commodities, and thus increase the time and costs of Customs Office controls and all public inspections. The Polish Customs Service has to identify restricted areas and monitor them in order to prevent unauthorised access, and also implement measures to prevent weapons, dangerous substances and devices being taken into vessels or into seaports facilities. It also enables the marine container terminal operators to move containers from the vessel in short time petiods and facilities the Customs and port clearance by the marine forwarders or clearing agents by streamlined means, as the system also facilitates electronic import clearance directly to the Celina Customs computer. However, the system still relies on the accuracy of the data and information supplied in the cargo manifest, and those data and information may not be sufficient to provide the exact details of every cargo contained in every container, especially groupage/consolidated LCLs. Only that data and information supplied as a result of the information, which is also used for the purpose of the issuing of a bill of lading, will be found on the cargo manifest. This information may be insufficient for Customs purposes, and may result in greater numbers of containers being selected for security by Customs at the port of arrival. The authorised economic operators (AEO) or Customs Agencies submit electronic online import declarations directly to the Celina computer' system, which sends back an acknowledgement along with the calculation of import duty and VAT in the form of an entry acceptance advice. Each import declaration represents the cargo in each container, which may be further detailed on the Celina cargo manifest.

Apart from organizational and financial restraints, the development of a uniform PCS is hampered by the input, i.e. the trade related information itself. Data which usually involves trade and transport documentation is not standardized, or it is only to a certain extent. As demonstrated, the Polish Customs Service are considered to be

the perfect authority to deal with security. For this reason, the Customs Service should be the key player in the Polish National Port Community System, given they have the necessary risk management techniques to target high-risk containers and commodities, they are able to collect and analyse the necessary data and information for controls and inspections, and most probably, have the necessary equipment. Anyway, the Polish Customs Service now fulfils a new upgraded role when a few years ago their main task was to collect import duties and taxes. Currently, they also have a tendency to act as security inspectorates of imported and exported containers and commodities.

## 6. PROBLEMS CONCERNING CUSTOMS AND BORDER CONTROLS IN POLISH PORTS

According to the Polish and EU law, imported containers and commodities have to be controlled and inspected by Customs Office, but – in the case of fresh products – they are also subject to phytosanitary, sanitary, veterinary and others public units controls and inspections. In Poland, the main authorities responsible for exercising control and conducting inspections are: the Polish Customs Service, the Veterinary Inspection, the State Sanitary Inspection, the Plant Health and Seed Inspection, and the Agriculture and Food Inspection. The importers have to deliver the cargo physically to have it checked by Customs Officers and to assure direct access to the inspected container. Nowadays, this importer's obligation generate serious difficulties for Customs Offices when a very large vessel calls at the Polish seaport with a large number of customs clearance orders.

To solve the above-mentioned problem, the Polish Customs Service prepares for electronic customs clearance when containers and cargoes are still aboard the vessel at sea. The Polish Customs Service currently guarantees an efficient customs clearance for such instances, although all necessary data and information must be first provided electronically by the importer or their representative e.g. the forwarder. Such solution makes it possible to prepare some containers' operators into a proper service container unit when containers and cargoes are still on board the vessel at sea. All crucial data and information are contained in the cargo manifest, which is delivered by the vessel operator and the last marine container terminal operator as well. The data and information are then entered into the terminal operating system of marine container terminal operator and receive their "expecting" status, as long as the container unit stays aboard the vessel. Moreover, the same data and information pertain to public inspections, including Custom Service. Thanks to the prior-obtained data and information by the Customs Office, the customs officer may conduct risk analysis of the container and commodities earlier, planning reactions and the method of control and inspection once the container unit has come to the Polish seaport onboard the vessel. The most extensive knowledge, however, concerns: type of cargo, its quantities, its value and its place of destination for traders – the exporter and the importer. Under such circumstances, the importer, who is well aware of all of the above-mentioned trade parameters, may submit customs clearance before vessel with cargo on board comes to the marine container terminal - of course, if there is no need to exercise controls and conduct inspections by such public units as veterinary, fishery, phytosanitary and so on. Such solution is called customs clearance at sea, because the primary idea relies on submitting customs clearance into the Customs Office, when cargo is still onboard the vessel at sea. This solution allows the Customs Office to prepare for the clearing of goods through the customs based on data and information delivered by the importer. Anyway, data and information must provide full accuracy and reliability and allow to be filled in a SAD document, using the data and information completed and confirmed by transport and trade documents. In this situation, the submitted custom clearance is effective. When a vessel has entered the seaport with cargo and the cargo is being unloaded in the marine container terminal and the data and information are sent to the customs information system (e-customs), accounting for any customs objections - then the cargo is automatically released by the Customs system from the procedure of free turnover in the UE area. This solution allows the importer or their marine forwarder be vested with cargo after directly calling the vessel into the Polish seaport. By doing so, the above-mentioned problem of the accumulation of custom clearance orders after the vessel's entering in the Polish seaport. Moreover, all operators of the marine logistic process may well be prepared to serve the cargo, and it should allow to cut the costs and time for all marine logistics chains providers whose operate in the Polish seaports (Florczyk (2015), pp. 14-15).

## 7. POLISH E-CUSTOMS SOLUTIONS AS A PCS FOUNDATION

In Poland, Customs Service has developed two very modern information solutions, namely: a control system based on one-stop-shop platform (System of Control's Coordination – SCC) and the "Ports 24" programme. The first information system concerns permissions granted by the Customs Office on running a temporary storage warehouse, which is used by the marine container terminal operators to manage and count containers that come in and out of the terminal, or that are stored in it. According to the requirement of the "Ports 24h" programme (Figure 3), this information system has provided access for all Governmental Inspections and private companies to directly engage in container and commodity-related operations. Using the system, the Governmental Inspections may make a note on every controlled and/or inspected container/commodities or on every decision made regarding the proper destination of the cargo.

Every note is entered in the online information system by public inspectors. The information in the system is available to all authorized persons immediately after entering it into the electronical platform. By "authorized persons", the author means: Customs officers, importers, customs agents and forwarders, and so on. It allows immediately make a customs clearance using all imported needed data for such inspections.

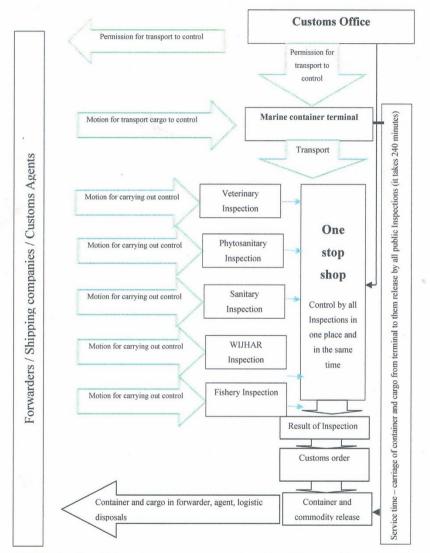


Figure3. Simplifying statement circulation used by different public control inspections

Source: Florczyk (2015), pp. 14-15.

The one-stop-shop platform is a tool to control containers or commodities in one time and in one place by all governmental inspections. To conduct an inspection, one needs to appoint a specific time and place. The terms and conditions of such inspections are presented for clients in regulations of the marine container terminal operator. The marine forwarders, after ordering cargo inspections, ask the Customs Office for the permission for their container carriage to fix place and they submit a transport order to the marine container terminal operator.

In the process of cargo inspections, there are two places of one-stop shop. If there is fresh cargo, then the place of such control is indicated by Sanitary Inspections. If there are other cargoes than the fresh ones, then the place of control is indicated by the marine container terminal operator. Every place of control and inspection is properly marked and in the area of cargo control there are no ongoing operations on commodities.

In the process of control directly participating are the following parties: control institutions, marine container terminal operator and marine forwarders whose are representing importer's interests. The participation of these persons in control process guarantees prompt access to containers and commodities so as to control and properly supervise the cargo. Under the control, the participation of marine container terminal operator' representative is very important because he or she runs temporary storage warehouse and is responsible for proper conditions of the commodities.

Nowadays, there are large facilities for marine forwarders because they can order control by single terminal window on-line ("mini-pcs" – TOS) and they can read results of such control or inspection on their computer screens. Fixing one place and one time for control and/or inspection give opportunities to run all logistics operations during one shift of a marine container terminal operator.

Thanks to the modern information system and effective acts of all Governmental Inspections and representatives in cargo operations, it means that time between cargo transport from marine container terminal for control and/or inspection all public units lasts between 3 and 4 hours (Florczyk (2015), pp. 14-15). After this period of time, the Customs Office releases the container and the commodities.

Anyway, the importer makes a decision on when the container unit will be transported outside the marine container terminal. The decision is based on his or her economic account and the effectiveness of some of his or her logistics operations, e.g. using the just-in-time rule. The importer may leave the container with cargo inside the marine container terminals located in Poland for up to 45 days. During this time, the cargo may be stored inside the terminal without any customs-tax payments.

The importer may transport cargo from the marine container terminal at any moment. Thanks to joint control of all inspections in one time and one place, and having the guarantee of prompt and effective acts in the marine container terminal, the importer archives additional value for his or her international activity.

Highly facilitating for container services in the marine container terminal area is AEO and local solutions called first-out-first cleared. The AEO status allows to use some facilitations concerns customs control in respect to safety and security of the cargo and/or the use of certain according to customs procedures. If the Customs Office would like to control the cargo, it must be done very quickly. The essence of AEO relies on some facilitations when all participants of the logistic chain have it. It means that when the AEO status involves the following parties: the producer, all carriers, marine container terminal operators, marine forwarders, importer, then the facilitations are highly efficient.

In turn, the first-out-first cleared solution (first out from the marine container terminal – first to be cleared) is used when there are a lot of customs orders. By using such solution, there is some possibility to discharge bottleneck in the sea container terminal area. New solutions of integrated information system in the Polish administration can help facilitate the effective service of containers in the Polish seaports (Florczyk (2015), pp. 14-15).

### 8. CONCLUSIONS

In the above-discussed broad scope of activities of the Polish Customs Service and other Governmental Inspections in Poland, the Customs Service should play a very important role in developing the Polish National Port Community System. In this new electronical platform, the following data and information should be entered: cargo declaration that provides detailed information about freight avoiding repetitive input of the same data; electronic customs tariff; single customs declaration, customs summary (supplementary customs declaration), summary declaration, simplified procedures, transit, dispatch and receipt, customs warehouse, inward processing, processing under customs control, customs taxes declaration, creates import inventory, record for writing off Customs entries and record for scrutiny by all Government Inspections, and so on.

In the tradition of the port community system, it is tempting that Port Authorities and also Customs Service should act as "facilitators" in the Polish National Port Community System. Anyway, the Customs Service should constantly rethink and broaden their role as facilitator. The Polish Port Authorities should work together with Customs Service and a number of other stakeholders (carriers, shippers, transport operators, and other logistics providers) to identify and address issues affecting port community system performance.

The scope of port authorities and Customs Service should go beyond that of traditional facilitators. Both public units can play an important role through an active engagement in developing the Polish National Port Community System, which will make the same facilitations for inland container distribution and intermodality. Direct and indirect forms of cooperation with notes and market players in port community system constitute probably the most important role for Polish port authorities and Polish Customs Service since gaining competitive benefits will become increasingly a matter of going beyond the Polish seaports boundaries, both in terms of physical container/commodities movements and data and information flows.

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## MEASUREMENT OF SUPPLY CHAIN EFFICIENCY – SELECTED ISSUES FOR RESEARCH AND APPLICATIONS

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### Abstract

The increase in the share of maritime container traffic in the global structure of transport had caused dynamic development and strengthening of the market position of shipping companies, shipping alliances enhanced this effect. Container sea transport has become an integral part of global supply chains, in which the dominant position have been reserved for shipping companies. Crucial factor for the proper functioning of the supply chain is efficiency, which is also very extensive concept. This paper provides explanation and division of this idea on time efficiency, cost efficiency and spatial efficiency. The literature review has been made concerning various levels of efficiency and measuring of global supply chain efficiency in context of maritime container transportation. Due to strong position of shipping companies, supply chains need to adapt and reconfigure in the way of advancing competitive advantages in other fields than maritime transportation. Also based on the literature review an attempt is to made to determine the most suitable strategy for supply chain. Finally, the limitation of this paper and future research directions are presented.

**Key words:** container transport, supply chain management, measurement of efficiency, supply chain efficiency

## **1. INTRODUCTION**

Introducing containers to global transportation was a revolutionary and innovative phenomenon that implied the need to change the then-existing transportation model. The possibility of utilizing intermodal transportation containers made it possible to use one means of transportation for transporting goods of different kinds. The maritime transport market had to adapt to the new conditions, such as through readjustment of vessels for shipping containers and later also through readjustment of ports for their handling. This type of adaptation significantly reduced transportation costs (Lee & Song, 2017, p. 442), thereby optimizing the cost efficiency of the supply chain passing through maritime container shipping markets. Reducing transportation costs also prompted further processes that helped liberalize global trade, as well as open up and develop new markets. Containerization is considered to be the main catalyst for globalization in the 20th century (Bernhoffen et al., 2016, p. 36). The dynamic growth of the new transportation branch strengthened the position of shipping companies which, in order to further increase their market share, started to establish strategic alliances that led to reduced costs and increased efficiency of the

service provided. Such agreements, based on the creation of a supply chain, allowed them to seek and gain sources of competitive advantage in other areas of business activity of both the transportation company and its customer.

The competitive advantage of the supply chain is expressed in the increased value delivered to the final customer. The way to achieve this objective is to improve the efficiency of the chain, e.g. by its readjusting, lowering its operating costs or limiting the duration of operations. The concepts of supply chain management (SCM), understood as various ideas combining supplier relationship management, production management and distribution management (Caniato et al., 2013, p. 286), will be helpful in achieving these goals.

The issue of supply chain efficiency is an area of interest for many researchers (Brandenburg, 2016; Beamon, 1998; Gunasekaran et al., 2004; Mathivathanan et al., 2017; Banaszewska et al., 2012). In spite of this, however, there has not been much space in the literature devoted to the discussion of the maritime container shipping markets with reference to supply chain efficiency.

The aim of this paper is to attempt to explore the efficiency of the supply chain operation on the maritime container shipping market and come up with an optimal supply chain management strategy based on the conducted literature research.

This paper is divided as follows:

- Section 2 reviews the literature on supply chain management strategies, chain efficiency and its performance, and then divides the performance into time, cost and spatial;
- Section 3 provides an overview of the literature on selected performance indicators taking into account the proposed efficiency breakdown;
- Section 4 discusses strategic alliances in the maritime container shipping market, including their impact on the supply chain, and then proposes an SCM strategy that optimizes the supply chain efficiency of the maritime container shipping market;
- Section 5 describes research limitations and further research perspectives;
- Section 6 presents final conclusions.

# 2. SUPPLY CHAIN MANAGEMENT (SCM) – OVERVIEW OF SELECTED LITERATURE

#### 2.1. SCM strategies – lean, agile, resilience

SCM was a response to changing market conditions, market liberalization and growing customer expectations. Based on the above definitions, it can be said that the primary task of SCM is to integrate and coordinate processes and relationships occurring inside and outside the supply chain in the context of maximizing added value, which translates into surplus values throughout the supply chain. The fulfillment of the above tasks should account for the supply chain strategy, determined in terms of market conditions and the specificity of goods, by implementing a specific SCM paradigm. The most popular SCM strategies should include *lean* (Kisperska-Moroń & De Haan, 2011; Charlampowicz, 2016; Stratton & Warburton, 2013;

Nieuwenhuis & Katsifou, 2015), *agile* (Purvis et al., 2014; Christopher, 2000; Stratton & Warburton, 2013; Kisperska-Moroń & De Haan, 2011; Charłampowicz, 2016; Nieuwenhuis & Katsifou, 2015) and *resilience* (Kamalahmadi & Parast, 2016; Carvalho et al., 2012; Kristiano et al., 2017).

The concept of Lean Supply Chain (LSC) derives from the *Toyota Manufacturing System*, introduced in Toyota to – simply put - improve performance with lesser effort (Nieuwenhuis & Katsifou, 2015, p. 234) by introducing the "*Just-in-time*" system and automation (Waqas Azfar et al., 2014, p. 805). None the less, the implementation of the above concept is possible provide that there is stable and predictable demand. The main objective of the lean strategy is cost reduction, implemented via reducing and eliminating waste (*Muda*). The cost-based approach found in this concept makes it possible to maintain the cost efficiency of the chain operation (Stratton & Warburton, 2003, p. 184).

The Agile Supply Chain (ASC) strategy is associated with a rapid response to unpredictable changes in demand (Kim & Chai, 2017, p.44; Gligor et al., 2015, p. 71). (Christopher, 2000, p. 38-40) identifies 4 characteristics to be had by a truly agile supply network: market sensitivity, virtualization, process alignment, networkability. (Agarwal et al., 2007, pp. 444-448), meanwhile, speak of a total of 15 variables contributing to the improvement of agility of the chain. The results of the study outline 7 factors that influence the agility of the supply chain (Agarwal et al., 2007, p. 453). These are: customer satisfaction, quality improvements, costs reduction, delivery times, new product launches, customer service improvements and lead-time reduction. The principal objective of the ASC is to meet the customer's expectations in the context of a faster delivery time thanks to permanent willingness to respond to demand changes. The answer to the change may assume the form of a chain readjustment (Charlampowicz, 2016, p. 243).

The concept of resilience, meanwhile, has to do with the ability (possibility) to operate free of errors in a situation full of disruptions and to return to the initial state after the disruptions disappear (Elleuch et al., 2016, p. 1449). (Brusset & Teller, 2017, p. 60) believe that truly Resilient Supply Chain (RSC) is a chain in which, despite disruptions and unpredictable changes, the supply chain still manages to fulfill its tasks and deliver its products or services. (Soni et al., 2014, pp. 13-15) identify 10 RSC enablers based on surveys and the literature. These are: agility, collaboration among players, information-sharing, sustainability in supply chain, risk and revenue sharing, trust among players, supply chain visibility, risk management culture, adaptive capability, and supply chain structure. Then, (Liu et al., 2017) propose the following RSC components: risk management, agility, integration and SC (re-)engineering. (Kamalahmadi, M. & Parast, M., 2016, p. 121-122), meanwhile, distinguish factors such as: adaptability, flexibility and agility as key elements of a RSC.

Choosing the right SCM strategy is related to the characteristics of the supply chain and the market through which it operates. The main purpose of implementing a specific SCM strategy should be to improve the efficiency of the supply chain, which can be manifested e.g. in the form of cost reductions (cost efficiency) or time reductions (time efficiency). (Swink et al., 2014, p. 9) are of the opinion that the

highest level of efficiency and performance is achieved through the use of lean operations.

## 2.2. Supply chain efficiency

The literature on the subject fails to distinct between concepts and indicators of efficiency and performance, which are conceptualized the same (Ganga & Carpinetti, 2011; Shafiee et al., 2014; Estampe et al., 2013). Then again, some authors (Chopra & Meindl, 2016, p. 26) define efficiency as one of the components of performance, understood as inverse of the cost of manufacturing and delivering the goods to the customer. The above definition is in line with the economic take, but it does not match the logistical aspect that can be expressed by the timing of the operations in question. (Roh et al., 2014, p. 201) considers an efficient supply chain to be one that aims to achieve cost efficiency by eliminating waste and processes not generating any added value. It follows from it that an efficient supply chain strategy should be implemented through the implementation of the LSC. However, in considering the chain efficiency with respect to factors such as time of order fulfillment, it appears that - due to its characteristic - the ASC-based approach would prove a better solution. For this reason, the author believes it is necessary to divide efficiency (as a component of the chain efficiency) into time-related, cost-related and spatial, in order to better identify an appropriate strategy for the chain examined.

## 2.2.1. Time efficiency of the supply chain

In spite of the large emphasis placed costs in the supply chain, their reduction will not always prove consistent with the overall strategy. Whenever a supply chain is passing through a highly uncertain and volatile market, it may be that reducing delivery time, capacity to making rapid changes and readjustments will be more important than cost reduction in either achieving or increasing competitive advantage. Such characteristics are typical to the ASC, whose main objective is to provide value as quickly as possible.

Operating a supply chain on a competitive market also entails the opportunity, and the need, to continually seek advantage in costs, space or service quality. The latter is very often associated with the time fulfillment of individual operations. Supply chain time efficiency is a feature of the supply chain that assumes the ability to meet customer expectations in the context of lead-time reduction. Other factors affecting time efficiency are: rapidness of information exchange, duration of physical operations, production time, delivery time.

## 2.2.2. Cost efficiency of the supply chain

A supply chain geared toward costs reduction is a characteristic feature of the LSC. The cost-cutting strategy is implemented by eliminating non-value-added processes and waste. The cost of the supply chain is defined as all significant costs present in the chain (Pettersson & Segerstedt, 2013, p. 358). It is necessary to define and determine costs at each stage of the supply chain in order to achieve cost

efficiency. (Gunasekaran et al., 2004, p. 338) note that supply chain efficiency is achievable through the use of a total logistics cost. In addition, they highlight the impact of cost-reducing activities in one area in terms of their impact on the costs of other areas (Gunasekaran et al., 2004, p. 338). Applying this to container shipping, this means that, for instance, an increase in a shipping batch to benefit from a lower unit rate would result in an increase in the cost of storage.

## 2.2.3. Spatial efficiency of the supply chain

Geographic distribution of the centers of individual links and their network partners has an impact on the supply chain readjustment and transport organization, being also an important determinant of competitiveness (Arnold et al., 2004, p. 256). The spatial layout of the network should be determined taking into account the shortening of the path that must be covered between the centers. This means that when forming the supply chain, the sum of total savings generated by individual network participants constitutes an important aspect. With that being said, factors such as reduction of transportation congestion should also be considered (Weisbrod et al., 2016, p. 460). Spatial efficiency of the chain is related to the mutual relations between time and cost.

When setting up a supply chain, in the context of maximizing spatial efficiency, the following elements will be worth analyzing: physical location of individual links and partner, state and characteristics of the infrastructure linking the individual centers, and local regulations. The liberalization of regulations and the improvement of the condition and availability of infrastructure will affect the distribution of supply chain participants in terms of gaining competitive advantage. Such advantage will be achieved by obtaining a high level of spatial efficiency expressed in the form of optimization of the relationship between costs and time as in delivery time.

# **3. SELECTED INDICATORS OF EFFICIENCY AND PERFORMANCE OF THE SUPPLY CHAIN**

Proper indicators need to be used in order to determine the efficiency of the supply chain. Beamon (1998, p. 287-288) proposes a total of 17 performance indicators, which are either qualitative or quantitative. Among the qualitative indicators, there are: customer satisfaction, flexibility, information and material flow integration, efficient risk management and supplier performance. Quantitative indicators, meanwhile, are distinguished between those directly related to cost or profit and those that rely on customer responsiveness (e.g. lead-time reduction). The proposed indicators include some related to the time efficiency of the supply chain (e.g. lead-time reduction), cost efficiency (e.g. cost reduction) and spatial efficiency (information and material flow integration).

Gunasekaran et al. (2004, p. 336-339) came up with 46 indicators including the strategic, tactical and operational levels, divided into 4 activities: plan, source, make/assembly and deliver. Some of the indicators presented refer to time efficiency (e.g. efficiency of purchase order cycle time) and cost efficiency (e.g. cost per

operations hour). They points out, however, that due to the diversity of the supply chain, depending on the industry, not all indicators will be correct, which is why new, more desirable ones need to be developed. Researchers also discusses the Performance Based System (PBS) (Gunasekaran et al., 2005, p. 527) whose main tasks are: identifying business areas that create value and accurately estimate costs.

Kolinski and Sliwczynski (2016) highlighted the problem of transposing strategic objectives to the operational level. They proposed a system of indicators and metrics of evaluation of the efficiency of supply processes on operational level. Researchers presented seven calculation formulas related with supply efficiency in enterprises. Some of them are corresponding to time efficiency (e.g. the ratio of delivery timelineness).

Otto and Kotzab (2003) propose considering supply chain performance through a perspective-based approach. There are, according to them, six different ways to look at SCM: System Dynamics (SD), Operations Research and Information Technology (OT), Logistics (L), Marketing (M), Organization (O) and Strategy (S). Some of the perspectives (namely SD, OT, L, O) present performance indicators related to time efficiency. Characteristics of individual perspectives with respect to their goals under SCM prevents the development of time, cost and spatial efficiency indicators in each case. (Balfaqih et al., 2016) reviewed supply chain performance measurement systems in terms of approaches and techniques applied. The most popular approach is perspective-based, followed by process-based and hierarchical-based approaches. He also discussed the use of particular techniques for measuring chain performance. Among the most popular are: survey/Delphi and uncertainty-based techniques (Balfaqih et al., 2016, p. 144).

Chopra & Meindl (2016, p. 44-59) identify 6 drivers of supply chain performance, including: facilities, inventory, transportation, information, sourcing, pricing. They also present a total of 48 indicators for all the factors, among which are those related to time, costs and space efficiency. Additionally, they emphasize that achieving competitive advantage depends on the relationship between logistic and functional performance indicators of the supply chain.

Carvalho et al. (2012, p. 337-338) defines two indicators related, respectively, to the field of logistics and costs, which were used to evaluate the SC so as to improve its resilience. The proposed indicators are associated with the previously defined chain efficiency dimensions. Lead Time Ratio expresses time efficiency, whereas Total Cost demonstrates cost efficiency.

Shafiee et al. (2014) examined the efficiency of the food industries supply chain in Iran, assuming a total of 15 efficiency criteria (e.g. customer response time, learning cost). They developed a DEA network model based on the BSC approach with a 4segment supply chain (financial perspective, customer perspective, internal process perspective, learning and growth perspective).

The basic criterion for selecting specific indicators will be the scope and nature of the information one has regarding the supply chain. Knowing the objectives of the supply chain allows for implementing measures that focus and control a particular link. It may often prove impossible assuming a holistic approach, understood as the implementation of indicators measuring the entire supply chain.

## 4. SUPPLY CHAIN EFFICIENCY ON MARITIME CONTAINER SHIPPING MARKETS

#### 4.1. Strategic alliances

Grzelakowski (2013, p. 122) notes that the maritime container shipping market (MCSM) is currently a strongly integrated market. Responsible for this state of affairs are the operators of global supply chains and the cause of this phenomenon is, among others, increasing transportation capacity and increased share of high-value goods in transported cargoes. Testament to it is the fact that over the last two decades (1990-2009) total port handling increased more than five-fold (Notteboom, 2012, p. 231). Despite the reduction in cargo flows on the main routes, the volume of transported containers amounted to 175 million TEU in 2015 (UNCTAD, 2016, p. 17). Over the past 12 years, meanwhile, the average size of a container ship more than doubled (2.5 times, to be exact) (UNCTAD, 2016, p. 42).

The MCSM has to face very volatile and rapidly changing market realities (Notteboom, 2002, p. 102). The strong concentration of the market on the supply side is expressed in two ways: subjective capital integration, and organizational and functional form expressed through alliances established on the main routes of container transportation (Grzelakowski, 2013, p. 126). The reasons for these strategic agreements are: risk sharing, economies of scale, knowledge and technology exchange, vertical integration and strengthening of market position (Rau & Spinler, 2017, p. 157). Referring to the service characteristics where the main factors are port calls, average number of deployed vessels and average duration, there are minor differences among alliances (Panavides & Wiedmer, 2011, p. 36). Research conducted by (Rau & Spinler, 2017, p.170) confirms that the main drivers of change in the alliances are: competitive intensity, alliance complexity cost and freight rate volatility, while shorter lead times increase market concentration. Participation in the alliance has no influence on management, including sales and marketing, pricing or maintenance of vessel (Stopford, 2009, p. 534), and besides alliances compete with each other (Lee & Song, 2017, p. 445).

Widespread use of the slow-steaming strategy (Grzelakowski, 2013, p. 124) has negatively affected the time and cost efficiency of the supply chain by increasing the time it takes to transport goods. Lee and Sang (2017, p. 459-462) distinguish three types of slow-steaming (21 knots, 18 knots and 15 knots versus the design speed of 23-26 knots) and present two slow-steaming models. They also note that the above strategy is applied by practically all shipping lines to a very large extent.

The literature is lacking in research that would determine the impact of strategic alliances on supply chain efficiency in time, cost and spatial matter.

#### 4.2. SCM strategy on the maritime container shipping market

In the event of a prolonged transportation time, caused by the implementation of a slow-steaming strategy, the main actions are to seek both time and cost savings in other links in the supply chain. The key to success, then, is supply chain integration. The immanent feature of the transportation industry is its vulnerability to integration (Matczak, 2015, p. 232). The MCSMs have witnessed unique transformations unheard of in other transportation sectors. Through mergers & acquisitions (M&A), as well as formation of alliances, with reference to Icontainers data, in April 2017, the three major alliances controlled 80% of the market<sup>23</sup>. Some M&As require the alliance to be reorganized (Lee & Song, 2017, p. 445).

In speaking of the above characteristics, the supply chain's ability to integrate, react quickly and perform tasks under unpredictable circumstances are all extremely important. The RSC concept fits the bill, as it assumes the ability to deal with unpredictable disruptions (Lam & Bai, 2016, p. 18). One aspect of the RSC is agility. Yang (2014, p. 112) recognizes that agility is not a direct driver of supply chain performance, although it reinforces its performance through cost efficiency. The RSC concept assumes the chain operates in a highly unpredictable environment, where it must continually carry out tasks irrespectively of the disruptions. Operating under such conditions require the implementation of a risk management approach aimed at reducing both present and future risks to which the participants are exposed (Yang, 2011, p. 392). Liu et al. (2017) also stress the need to establish a risk management structure as a key to improving the RSC performance.

Within the framework of the proposed definition of the RSC, Kamalahmadi and Parast (2016, p. 121-122) present three RSC phases: anticipation, resistance, recovery and responses. Additionally, they point out that agility is one of the most important aspects of the resilience-based management strategy. This is an immanent feature of the RSC, which forms part of the context of the maritime container shipping market (MCSM) operation. The cost associated with the RSC is high, resulting among others from the need to implement technology in order to better deal with the variability of demand in terms of type and quantity.

Seeking time and cost efficiency in a situation of high demand uncertainty is characteristic of the RSC. The area of knowledge connected with the relationship between the RSC and the MCSM is prospective, with high growth potential.

## 5. RESEARCH LIMITATIONS AND FURTHER RESEARCH

#### 5.1. Research limitations

The ability to utilize and have full access to *Science Direct* journals made it possible to review the literature in interesting areas. None the less, the fact of relying on only one database greatly limited the possibility of conducting a more extensive literature research. No access to the base *Emerald Insight* impeded carrying out a fuller investigation and presentation of the phenomena of measuring performance and efficiency in the supply chain.

Another research limitation is the lack of research on the impact of the MCSM characteristics and readjustments on supply chain performance with respect to time, cost and space.

<sup>&</sup>lt;sup>23</sup> <u>http://www.icontainers.com/us/2017/03/21/new-shipping-alliances-what-you-need-to-know/</u> - access 11.05.2017

One other significant research limitation is the lack of a broader possibility to verify the relationship between the selected SCM strategy for the transport services market (here, the MCSM) and time, cost and space efficiency. These relationships are treated by transportation companies as an element of commercial secrecy and thus access to them is limited.

#### 5.2 Further research directions

Balfaqih et al. (2016, p. 145) point out that the area for measuring supply chain efficiency is still very fertile. Undoubtedly, further action is required in order to develop tools that will account for the market and commodity characteristics with respect to time-related, cost-related and spatial efficiency. Apart from that, to better manage the global SC, it seems necessary to develop efficiency measures on the MCSM.

It is necessary to conduct two-directional research to be able to gain a better understanding of the impact of strategic alliances on the efficiency of the supply chain, as well as to better understand the measures that take into account time, cost and spatial efficiency of the supply chain. The above indicators should be confronted with empirical data to determine their suitability. Carvalho (2012, p. 340) argues that further research on the relationship between the RSC strategy design and the SC performance is needed.

Determining the impact of strategic alliances on supply chain efficiency will enable developing more efficient performance measures, which translates into having more complete information about the supply chain and thus gain competitive advantage.

## 6. CONCLUSIONS

The changing market conditions and strong market concentration in the container shipping branch imply the need for continuous adaptation of the supply chain. This readjustment must be in line with the adopted strategy as well as market and commodity characteristics. The strong position of the MCSM's supply side, resulting from M&A practices and strategic alliances, along with the slow-steaming strategy they have adopted, necessitates seeking savings in both time and cost, as well as in other areas of the chain than the maritime shipping market. The resilient concept practically the only one SCM strategy that corresponds to the MCSM market characteristics, related with the MCSM's impact on reducing the efficiency of the supply chain, forcing the operators to implement a strategy for normal operation in the event of disruptions. The RSC fits the bill it promotes timely fulfillment of entrusted tasks in spite of disruptions, which translates into gaining competitive advantage.

The aim of this paper was to attempt to explore the efficiency of the supply chain operation on the maritime container shipping market with respect to time, cost and space, and to come up with an optimal SCM strategy. The supply chain performance measures were discussed in the context of their fit for performance in all these three dimensions. The literature on establishing strategic alliances on the MCSM and their impact on chain efficiency were also reviewed. Moreover, the usefulness of the RSC adaptation to the supply chain passing through the MCSM was discussed in order to maximize efficiency (or minimize its losses).

The main conclusions of this paper are: (i) the RSC proves an efficient SCM strategy for the SC passing through the MCSM; (ii) the need to develop SC performance measures with regard to link characteristics in the context of the MCSM; and (iii) empirically determine the impact of strategic alliances on supply chain efficiency with respect to time, cost and space.

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## IMPACT OF CHANGES IN STANDARDS AT IMPROVING EFFICIENCY OF WORK AND QUALITY OF WORKING PROCESSES IN MARITIME COMPANIES

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### Abstract

The co-ordination of different business factors in the maritime company implies more detailed understanding of the concept of improving standards in business. In order to improve business of the company, it is necessary to continually increase the level of individual human resources standards related to human resource management. In this context, more detailed research into changes in standards related to the training of employees in maritime affairs, the new administrative rules in business and improvement of the convergence of education system, legal regulations and the actual state of affairs related to maritime companies will be explored. The aim of the paper is to explore the above-mentioned parameters in order to link the improvement of standards with changes in certain segments of the work related to the efficiency of work and the improvement of the quality of work processes. The purpose of the paper is to provide an insight into the state of affairs and changes that have occurred in the domain of standards improvement over the last 5 years and to discover their impact on mentioned parameters in a truly limited environment. Since these indicators are impossible to evaluate on the basis of measurable data, the survey is based on assessing seafarer's estimates. The research methodology is based on data collection through an on-line questionnaire fills by seafarers. The processing of collected data will be based on statistical analysis using correlation and various descriptive statistical methods. Since research is based on the period of the last 5 years, the analysis of the theoretical bases found that no similar research has been carried out so far. The aforesaid issues were explored solely on a theoretical basis, therefore practical research considers interesting to scientific and professional public. The conclusion of the paper gives a cross-section of the continuous process of standardization and explains its impact on the business in the domain of marine logistics.

Key words: standards, working processes, enterprise, maritime affairs

## **1. INTRODUCTION**

Observing the above mentioned problem is based on the findings that are closely related to changing standards in maritime business operations. The improvement of the standards of maritime enterprise is a continuous process that lasts from the second half of last century to the present. Standards that are to be analyzed in this particular case relate to the STCW Convention which involves a set of standards that directly relate to maritime affairs and refers to human potentials. The standards were set by the International Maritime Organization (IMO). The Convention prescribes minimum standards related to training, certification of employees and compliance of businessrelated systems. The amendment of the standard was adopted in 2010 and the application was foreseen for the period from 2012 to 2017. It is precisely the period in the focus of this research. Systematic and controlled improvement of the standards aims to increase the level of training of the employees in the maritime company while simultaneously raising the level of health control, conditions, quality of work and environmental standards. At the same time, with the above mentioned process, the goal is to harmonize legal and educational system that will implement these standards in a way that incorporates them into the real sector. Implementation includes all participants that can be divided into four core groups: regulators of rules, regulations and guidelines, maritime companies, maritime workers, and educational institutions. All of the mentioned benchmarking factors should affect the business operations of maritime companies that are required to implement these standards.

It is precisely the aim of the paper to explore individual indicators of business standards that would be linked to improve the efficiency of work and quality of work processes on board. The following standard research study is divided into three areas related to seafarer's ability, administrative business factors, and compliance with all business-related systems. In accordance with the above facts it is possible to form following hypothesis:

H1: The change of seafarer's qualification standards has had an impact on the improvement of work and work processes on board.

H2: Changing the administrative standards on board had an impact on improving the work and work processes of the maritime company.

H3: Changing the compliance of all system factors affected the enhancement of work and work processes on board.

H4: Changing standards related to seafarer's competence has influenced the efficiency of operation on board.

H5: Changing the administrative standards on board had an impact on the efficiency of the work on board.

H6: Changing the consistency of all system factors influenced the efficiency of the work on board.

Following the presented hypothesis, the research should analyze in detail the individual segments of standards in maritime business that should directly affect the efficiency of work and improvement of work processes in maritime companies.

### 2. CONTROL OF OPERATIONS

The control process, as one of the management functions, is closely related to standardization. Business standardization is one of the key parts of the control process, which can be divided into four steps. The first step is to set standards. That is followed by performance measurements that compares with those standards, then performance evaluation, and in the end taking specific actions for correcting and improving standards. Standards are set as targeted values to compare the actual or expected effect. It is a set of benchmarks or criteria to evaluate the achievement of the goal. Well-established standards can point to the fact that the process deviates from the predicted frameworks during the process itself (Buble, 2006, p. 383-384). The reaction after the performance evaluation can be done in three ways, one of which is maintaining an existing state, then correcting the performance or changing the set standards (Buble, 2006, p. 387). According to Griffin, controlling is the supervision of organizational progress towards set goals and as such represents the final stage of the management process (Griffin, 2005, p. 12).

In order for certain targeted performance elements to be within the acceptable limits, control and regulation of business activities is carried out. Otherwise, the company would have no indication as to how much their performance deviates from the set goals. Control provides direction of adapting to changes in the environment, limiting the accumulation of errors, carrying organizational complexity and reducing costs (Griffin, 2005, p. 652-653). The precondition for carrying out the control is to express the goals. When setting goals, a series of segments related to: market position, profitability. innovation, success, management development, production. performance, employee attitudes, physical and financial resources, and social responsibility as a whole should be taken into account (Drucker, 1954, p. 8). The most commonly used principle for goal defining is SMART (Domijan-Arneri, 2014; p. 207):

- S (specific),
- M (measurable),
- A (achievable),
- R (resource bond),
- T (time bound).

Bureaucratic control can be distinguished from group control (Table 1). According to Buble, bureaucratic control is a formal and structured arrangement of individual and group behavior in the enterprise, and is regulated by a complex system of rules that include action, budget, and standards management. Group control is informal arrangement of individual or group behavior within an enterprise. Behavior in group control is regulated by group norms, corporate culture and self-control (Buble, 2006, p. 392).

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BUREAUCRATIC CONTROL	DIMENSION	GROUP CONTROL		
Employee Compliance	Goal of control approach	Employee commitment		
Strict rules, formal controls, rigid hierarcy	Degree of formality	Group norms, culture, self- control		
Directed toward minimum levels of acceptable performance	Performance expectations	Directed toward enhanced performance above and beyond the minimum		
Tall structure, top-down influence	Organization design	Flat structure, shared influence		
Directed at individual performance	Reward system	Directed at group performance		
Limited and formal	Participation	Extended and informal		

**Table 1.** Differences between two basic types of control in the organization

Source: Griffin, 2005, p. 668.

In general terms, control within an enterprise can be divided into operational control (orientation to converting resources into products or services), financial control (refers to cost control), structural control (deals with organization of structure elements), and strategy control (focus on effectiveness of all segments of business in relation to the set goals). The first step in establishing control is defining standards (Griffin, 2005, p. 656).

Operational control involves, among other things, quality control. Quality implies features of products or services that meet the customer needs, ensure their satisfaction and release of mistakes that would cause the business to repeat or could result in failure (Juran, 1998, p. 2.1-2.2). Quality management is carried out using the process known as "Juran's trilogy", which includes:

- Quality planning,
- Quality control,
- Improvement of quality (Juran, 1998, p. 2.5.).

ISO 9001 is the most widely used international standard that sets requirements for the establishment and maintenance of a total quality management (ISO Quality, 2015, p. 2). When it comes to maritime companies, emphasis is put on the quality of services that can be classified into six groups as follows:

- Quality in relation to resources (physical, financial, equipment, infrastructure, ...)
- Quality in relation to the results (product or service received by the customer)
- Quality in relation to the process (interaction between employee and customer)
- Quality in relation to management (effective selection and use of resources, employee professionalism, feedback, ...)

- Quality in relation to brand / reputation (customer perception of the company)
- Quality in relation to social responsibility (ethical perception of enterprises) (Thai, 2007, p. 495, 500.).

The implementation of a total quality management in the operations of maritime companies and continuous control is carried out with the aim of increasing business safety, i.e. reducing accidents and environmental pollution.

# 3. STANDARDIZATION SYSTEM FOR SEAFARERS - STCW (CHANGES IN MANILA 2010)

STCW Convention (The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers) is a set of standards of international value adopted in London in 1978 for seafarers on merchant ships. The convention was brought by IMO (International Maritime Organization), and came into force in 1984. The first significant amendment to the Convention was 1995. The Convention prescribes minimum standards in relation to training, certification and watchkeeping for seafarers (Dirks, 2001, p. 2). The next major change was in Manila on June 25, 2010, which prescribed the beginning of the transition period from January 1, 2012 to full implementation as of January 1, 2017. These are amendments to the existing STCW convention, where existing rules and regulations have been updated in line with the development and forecasts of future problems<sup>1</sup>. Manila's amendments consist of eight chapters and 43 regulations, of which 15 refer to general provisions, five on nautical departments, seven on mechanical engineering and two on radio communications. Other regulations relate to special training requirements for seafarers (3), rescue, occupational safety, health and emergency (6), alternative certification (3) and watchkeeping  $(2)^2$ . All of these changes relate to certain stakeholders that directly or indirectly participate in maritime business operations (Table 2).

PARTY	ACTION					
	Promotion and awareness					
	Amendment of rules, regulations and guidelines					
	New certificates: Electro-Technical Officer, Able					
Regulator	seafarer					
	Review quality systems					
	Review MOUs (Memorandum of Understanding) and					
	create new ones (near coastal voyages)					
	Ensure health, training (include re-training) and					
Chinoumona	qualifications of crew					
Shipowners	Manning levels to meet hours of rest requirements					
	Prepare training funds					

 Table 2. The most important activities grouped by stakeholders

<sup>&</sup>lt;sup>1</sup> Ahmad, marine21.marine.gov.my, p. 2

<sup>&</sup>lt;sup>2</sup> Ibidem, p. 3

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Seafarers	Awareness of new requirements, especially on training and certification
Training institutions	Training programmes in place Restructuring of training courses Re-training of trainers Review quality systems

Source: Ahmad, Mohammad<sup>3</sup>

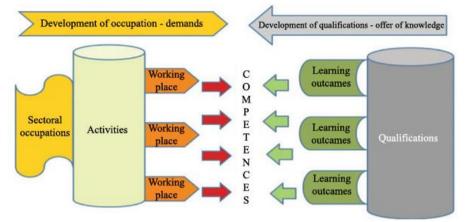
Changes from Manila, as well as the STCW Convention itself, place greater emphasis on seafarer's training. Successful execution of specific and complex tasks within the work process is not possible if employees have not previously acquired appropriate work habits, skills and knowledge. Professional training should result in increased efficiency of work and raising performance quality of work processes. Reaching a certain standards is achieved by introducing systematic and controlled training (Kiperaš, 1998, p. 50). Thus, due to the advancement of technology and changes in maritime conditions, Manila has adopted several amendments to new training programs or new requirements under the existing ones. Some of the changes are:

- New requirements for training in modern technology (ECDIS)
- New requirements for management, leadership and teamwork
- New requirements for security training including "piracy awareness"
- New requirements for marine environment awareness training
- Training for Electrical Engineers
- High voltage training
- A new training for able seafarers
- Introduction of modern training methodology (web-based learning)
- Improved measures to prevent fraudulent practices associated with certificates<sup>4</sup>.

Specific training is also prescribed depending on the type of boat. Thus, there are minimum requirements for training on passenger and RO-RO ships, oil tankers, liquefied gas tankers and chemicals (STCW Convention Familiarization with 2010 Manila Amendments, 2014). In addition to the training program, an important part of the seafarer's preparation for life and work on board is the educational process. Maritime Studies Programs in Croatia are aligned with the STCW Convention and are subjected to certification by the Ministry of Science, Education and Sports and the Ministry of Maritime Affairs, Transport and Infrastructure. The competences gained by such an education system make space for seafarers in the labor market because they meet the standards of maritime enterprises (Figure 1). Nevertheless, the radical changes to the STCW Convention in Manila, 2010 have failed to take into account the latest trends in education set by the Bologna Process, which has brought about some changes in the way of acquiring knowledge that differ from the STCW convention (Marušić, 2010, p. 13).

<sup>&</sup>lt;sup>3</sup> Ibidem, p. 9-10

<sup>&</sup>lt;sup>4</sup> www.warsashsuperyachtacademy.com



**Figure 1.** Competences - a common goal of the education system and the demand system in the labor market in maritime affairs

Source: Weiss et all; 2012, p. 12.

Training certificates are necessary when a seafarer departs at a ship, and are acquired by attending and passing seafarer's training programs after graduating from a secondary maritime school. Certification is done according to the STCW Convention. In Chapter VII, Rule VII / 2 on Certification of Seafarers states the following: "Every seafarer performing a function or a series of functions specified in the tables in chapters II, III and IV (chapters intended for deck officers, machines and radio communications) of the STCW Convention, will receive a certificate of competency or a certificate of proficiency"<sup>5</sup>.

Among the necessary certifications, seafarers also receive a certificate of environmental protection for which they are trained on a special training program. The marine environment problem is covered by the MARPOL Convention (International Convention on the Prevention of Pollution from Ships), and training is controlled by the STCW Convention. MARPOL handles all types of pollution including, for example, grease, oil, noxious liquid substances, harmful substances in packaged form, sewage, or garbage from ships, aircraft and platform carriers (Philipsen & Rigamonti, 2015, 7). In addition to this pollution, ships also have other adverse impacts on the environment, such as noise pollution, negative impact on marine flora and fauna damaging habitats, underwater and seabed by anchoring, propellers and hulls, pollution by antifouling paint or crossing of roads and collisions with sea mammals and turtles (Abdulla & Linden, 2008, p. 12-13, 22, 27, 33).

<sup>&</sup>lt;sup>5</sup> cil.nus.edu.sg, p. 41

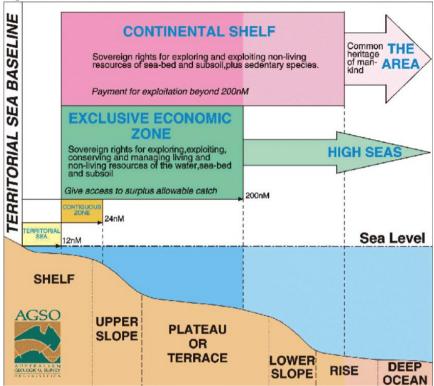


Figure 2. Classification of sea and undersea

Different levels of protection, through different laws and regulations, apply to different parts of the sea and the ocean (Figure 2). In accordance with the foregoing, maritime companies are obliged to comply with prescribed standards and act in accordance with the legal framework applicable in different conditions and areas.

#### 4. EFFICIENCY OF PERFORMING WORKING PROCESSES ON BOARD

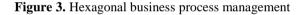
All the above-mentioned regulations and rules are brought and improved in order to increase the efficiency of the work on board and the safety of seafarers and passengers as well as increase of profits. The question that almost all business managers are asking today is how to reconcile the demands of all stakeholders, how to be and remain successful, and which techniques or methods to apply. Part of the answer lies in standard improvements. There are no unified definitions of standard improvements, but almost all agrees in one: standard improvements represent changes to the better, all that is shift from the current state, and brings financial or functional savings (Pipunić & Grubišić, 2014, p. 542). By combining two improvement models, Lean and Six Sigma, the overall process can be improved by reducing the number of

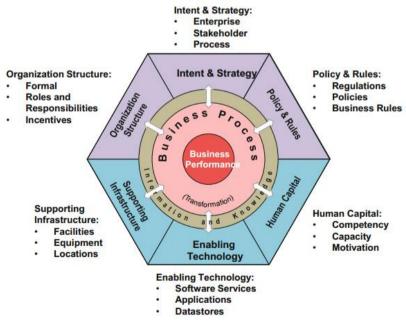
Source: Townsend, 2015, p. 8.

steps (Lean) and reducing the variation and eliminating errors within each business process (Six Sigma) (Skorikova, 2014, p. 170).

Business management, in a way to continuously improve work processes is part of the business organization (Figure 3). In addition, employee selection management has a certain impact on the performance of work processes. Some research related to individual human resource management segments confirmed that seafarers were partly negatively assessing the employee education segment, while assessing leadership as neutral (Vučur et al, 2016, p. 74). The established indicators point to the fact that there are a lot of possibilities for improvement the standards, that is duty of the company's managers that must have the knowledge and skills needed to improve work and work processes. Setting up activities to be performed, requires the definition of necessary knowledge and skills for which standards need to be precisely defined. In case of coordinated activities, operations of all participants must be described (Harmon, 2016, p. 18). Business function consists on related and similar interrelated jobs. They need to be performed with the purpose, in a way to link business tasks (Sikavica, 2011, p. 569).

Coordinated jobs require teamwork based on interlaced knowledge, but also raises the level of motivation and participation in work (Hanzu-Pazara et al, 2012, p. 319). In such an environment, capable seafarers are those that are well-trained, accept low levels of risk and are responsible for their work and the marine environment (Barsan et al, 2012, p. 89).





Source: Burlton; 2001, p.73

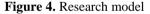
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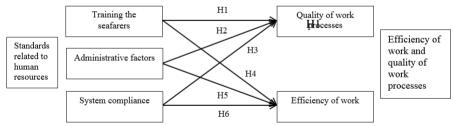
There are three types of job management: management processes that affect other processes, support processes that meet the internal needs (the needs of employees or need to carry out production-service processes) and central processes aimed to meet customer needs (von Rosing, Scheer & von Scheel, 2015, p. 439). All critical parts of the work process should be measurable. Process efficiency measures represent specific attributes of values and attributes of each product or service (Tenner & DeToro, 1996, p. 77). Measurement of business processes can be based on quantitative or qualitative indicators. In the case of quantitative indicators, it should be noted that the measurement principle is to take into account certain numerical values that can be expressed in financial or non-financial indicators. In the case of qualitative indicators, measurements are carried out on the basis of estimated values.

This research is based on the estimated values of seafarers due to the fact that the location of business processes is physically remote and as such is not suitable for access to information that are usually confidential.

#### 5. RESEARCH METODOLOGY

The research methodology was based on a perceptive view of seafarers that was expressed through an on-line questionnaire that was available to them over a period of 15 days in April, 2017. The survey questionnaire contained a total of 19 closed-type questions in which for a part of the question was offered a Likert scale of 7 degrees intensity ranging from a completely negative to fully positive trend of movement of each indicator. The questionnaire compiled a total of 154 seafarers from the Republic of Croatia. Linking indicators related to maritime business standards, which have experienced changes in the observed period over the past 5 years, and indicators related to the efficiency of work and improvement of work processes, research model was formed (Figure 4).





Source: Own production

The questions that will be answered in the following are: "Does improvement of standards affect the quality of work processes?", "Does compliance of standards affect work efficiency?" and finally "Which segments of standards are improved?".

Statistical data processing was carried out using Microsoft Excel 2010 data processing software and IBM SPSS Statistics 20. The testing of the offered hypothesis

is based on a correlation analysis, and the tests were conducted at a level of significance of 5%.

Also, through the descriptive statistics parameters, the survey includes indicators related to the characteristics of seafarers who participated in the research, as well as analyzed trends in the movement of individual segments of business.

#### 6. RESEARCH RESULTS

#### **6.1. Sample characteristics**

The analysis of the sample according to the basic features presents the characteristics of seafarers who participated in the research. The sample encompassed a total of 154 seafarers currently on board or were on board in the observed period, which will be analyzed for age, navigation, level of education, occupation and work position on board.

If the age of seafarers in the survey is considered, 1/3 of seafarers were between 36 and 45 years, 1/3 between 26 and 35 years, while 1/3 included all others.

If the navigation time is observed, it can be said that the pattern was somewhat different, so 36.4% of seafarers in the survey had up to 5 years of navigation, 16.9% between 6 and 10, 18.2% between 11 and 15 years, while the same percentage was applied to seafarers that had between 16 and 20 years of navigation. More than 20 years of navigation have had more than 10% of seafarers.

Considering the level of education, it can be concluded that 44.1% of seafarers had completed a higher school (bacc.), 28.6% secondary school, 20.8% high school (mag.), and 6.5% ended in an accelerated course or a special training program.

If calling of seafarers involved in the survey is analyzed, it is necessary to state that more than half of seafarers were nautical directions, about 30% of the sample referred to engineers, 10% to electricians, while the rest was the other crew on board.

Looking at the position on board, the survey included 23.4% captains or chief engineers, 22% I. officers, 24.7% II. officers, 13% III. officers, and 16.9% of other crews.

#### 6.2. Hypothesis testing

Due to the above-mentioned facts, survey model and features related to seafarers involved in the research, set hypothesis should be tested. The hypothesis testing is based on linking these indicators to obtain correlation test results based on which judgments will be made and to form concluding exploratory considerations. Since research involves sequential (ordinal) variables for hypothesis testing, a nonparametric correlation coefficient of rank correlation was used, showing the direction, intensity, and statistical significance of the relationship between the observed variables.

Overview of all used indicators in hypothesis testing: WWP - Assess the quality of work and work processes on board Impact of changes in standards at improving efficiency of work and quality of working processes in...

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CHF - Assess the trend of control of the health and fitness of seafarers on board

QTC - Assess the quality of seafarer training on the basis of a larger number of courses TEM - Assess the quality of seafarer's training on the equipment and materials used at the courses

LC - Assess the quality of the lecturers at the courses

EST - Estimate the encouraging to seafarer training by the company

NR - Estimate the number of rules, regulations and guidelines on board

ISO - Estimate ISO quality system on board

ECO - Assess the changes in ecological standards in the working environment on board

ACO - Assess the compliance of the actual condition on board with the prescribed STCW standards

STCW - Assess your knowledge of STCW standards

SHE - Assess changes in work efficiency on board

 $\ensuremath{\mathsf{EDU}}$  - Assess the compliance of the education system with the prescribed STCW standards

H1: The change of seafarer's qualification standards has had an impact on the improvement of maritime labor and work processes.

Seafarer's abilities in the hypothesis test are presented through indicators related to health and fitness training, training through a number of courses, equipment and materials used at the courses, the quality of the lecturers, and encouraging training by companies. These indicators are related to the level of quality of work and work processes of a company in maritime affairs.

			WWP	CHF	QTC	TEM	LC	ENC
	Correlations							
		Correlation Coefficient	1,000	,435**	,511**	,070	,250**	,358* *
	WWP	Sig. (1-tailed)		,000	,000	,194	,001	,000,
		Ν	154	154	154	154	154	154
	CUE	Correlation Coefficient	,435**	1,000	,332**	,275**	,177*	,169*
	CHF	Sig. (1-tailed)	,000,		,000	,000	,014	,018
Spearman		Ν	154	154	154	154	154	154
's rho	OTC	Correlation Coefficient	,511**	,332**	1,000	,459**	,343**	,421* *
	QTC	Sig. (1-tailed)	,000	,000		,000	,000	,000
		Ν	154	154	154	154	154	154
		Correlation Coefficient	,070	,275**	,459**	1,000	,419**	,312* *
	TEM	Sig. (1-tailed)	,194	,000,	,000		,000	,000
		Ν	154	154	154	154	154	154

**Table 3.** Correlation between seafarer training indicators and improvement of work

 and work processes in maritime company

LC	Correlation Coefficient Sig. (1-tailed) N	,250** ,001 154	,177* ,014 154	,343** ,000 154	,419** ,000 154	1,000 154	,184* ,011 154
ENC	Correlation Coefficient	,358**	,169*	,421**	,312**	,184*	1,000
ENC	Sig. (1-tailed) N	,000 154	,018 154	,000 154	,000 154	,011 154	154

\*\*. Correlation is significant at the 0.01 level (1-tailed).

\*. Correlation is significant at the 0.05 level (1-tailed).

Source: Own production using SPSS

From the presented results (Table 3) it can be concluded that there is a positive, significant and intense correlation between the majority of seafarer's qualification indicators and the level of labor quality and work processes of the maritime enterprise. The impact was not recorded only in the segment related to the use of equipment and materials at courses that cannot be directly related to the quality of work and work processes of the maritime company. Hypothesis H1 is accepted.

H2: Changing the administrative standards on board had an impact on improving the work and work processes of the maritime company.

The change of the administrative standards on board were based on the tendency of raising the number of rules, regulations and guidelines on board, and on the ISO system of quality and ecological standards of maritime business operations. These indicators are related to the level of quality of work and work processes of a company in maritime affairs.

	Correlations					ECO
	-	Correlation Coefficient	1,000	,049	,581**	,441**
	WWP	Sig. (1-tailed)		,273	,000,	,000,
		Ν	154	154	154	154
		<b>Correlation Coefficient</b>	,049	1,000	,223**	,289**
	NR	Sig. (1-tailed)	,273		,003	,000
Spearman's rho		Ν	154	154	154	154
Spearman's mo	ISO	<b>Correlation Coefficient</b>	,581**	,223**	1,000	,416**
		Sig. (1-tailed)	,000,	,003		,000
		Ν	154	154	154	154
		Correlation Coefficient	,441**	,289**	,416**	1,000
	ECO	Sig. (1-tailed)	,000,	,000,	,000	
		Ν	154	154	154	154

**Table 4.** Correlation between the indicators of administrative standards and the improvement of work and work processes of enterprises in maritime affairs

\*\*. Correlation is significant at the 0.01 level (1-tailed).

Source: Own production using SPSS

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From the Table 4, it can be seen that most of the indicators related to administrative factors have a significant, positive and intense impact on the quality of work and work processes of a company in maritime affairs. The impact on the quality of work and work processes wasn't noticed only in relation to the number of rules, regulations and guidelines on board. Hypothesis H2 is accepted.

H3: Changing the compliance of all system factors affected the enhancement of maritime work and work processes.

In accordance with the above-mentioned system factors involved in standards implementation, indicators relating to the compliance of the education system with the STCW standards, the compliance of the ship's actual status with the STCW standards, and the knowledge of STCW standards by seafarers have been explored. These indicators are related to the level of quality of work and work processes of a company in maritime affairs.

	Correlations			EDU	ACO	STCW
		Correlation Coefficient	1,000	,252**	,398**	,101
	WWP	Sig. (1-tailed)		,001	,000,	,106
		Ν	154	154	154	154
		<b>Correlation Coefficient</b>	,252**	1,000	,491**	,151*
	EDU	Sig. (1-tailed)	,001		,000,	,031
Spearman's rho		Ν	154	154	154	154
Spearman's mo		<b>Correlation Coefficient</b>	,398**	,491**	1,000	,278**
	ACO	Sig. (1-tailed)	,000,	,000,	].	,000,
		Ν	154	154	154	154
		<b>Correlation Coefficient</b>	,101	,151*	,278**	1,000
	STCW	Sig. (1-tailed)	,106	,031	,000	
		Ν	154	154	154	154

**Table 5.** Correlation between the compliance of all system factors and the improvement of work and work processes of enterprises in maritime affairs

\*\*. Correlation is significant at the 0.01 level (1-tailed).

\*. Correlation is significant at the 0.05 level (1-tailed).

Source: Own production using SPSS

Considering the presented results from Table 5, it can be concluded that there is a positive, intensive and significant impact of the compliance of the education system with the STCW standards and the compliance of the ship's actual status with the STCW standards to the quality of work and work processes of the maritime enterprise. The impact of knowing STCW standards by seafarers about quality of work and work processes has not been noted. Hypothesis H3 is accepted.

H4: Changing of standards related to seafarer's competence has influenced the efficiency of work on board.

Seafarer's competence in this hypothesis test is presented through indicators related to health and fitness training, the quality of education through a greater number of courses, the equipment and materials used in the courses, the quality of the lecturers, and the encouraging for training by the company. These indicators are related to the level of efficiency of the on board operations.

	Correl	ations	WEO	CHF	QTC	TEM	LC	ENC
	-	Correlation Coefficient	1,000	,368**	,500**	,126	,340**	,340**
	WEO	Sig. (1-tailed)		,000	,000	,060	,000	,000
		Ν	154	154	154	154	154	154
	CHF	Correlation Coefficient	,368**	1,000	,332**	,275**	,177*	,169*
	CHF	Sig. (1-tailed)	,000,		,000	,000	,014	,018
		Ν	154	154	154	154	154	154
	OTC	Correlation Coefficient	,500**	,332**	1,000	,459**	,343**	,421**
	QTC	Sig. (1-tailed)	,000,	,000	-	,000	,000	,000
Spearman's		Ν	154	154	154	154	154	154
rho	TEM	Correlation Coefficient	,126	,275**	,459**	1,000	,419**	,312**
	TEM	Sig. (1-tailed)	,060	,000,	,000,		,000,	,000
		Ν	154	154	154	154	154	154
	LC	Correlation Coefficient	,340**	,177*	,343**	,419**	1,000	,184*
	LC	Sig. (1-tailed)	,000,	,014	,000	,000		,011
		Ν	154	154	154	154	154	154
	ENC	Correlation Coefficient	,340**	,169*	,421**	,312**	,184*	1,000
	ENC	Sig. (1-tailed)	,000	,018	,000	,000	,011	
		Ν	154	154	154	154	154	154

Table 6. Correlation bet	ween seafarer	training i	indicators	and on 1	board	efficiency
	ween searcher	u u u u u u u u u u u u u u u u u u u	maicators	und on	oouru	criticitetic y

\*\*. Correlation is significant at the 0.01 level (1-tailed).

\*. Correlation is significant at the 0.05 level (1-tailed).

Source: Own production using SPSS

From the presented results (Table 6) it can be concluded that there is a positive, significant and intense correlation between most seafarer training indicators and on board efficiency. The impact is not recorded only in the segment relating to the use of equipment and materials at courses and cannot be directly related to the efficiency of the work on board. Hypothesis H4 is accepted.

H5: Changing the administrative standards on board had an impact on the efficiency of the work on board.

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The change of the administrative standards on board was based on the tendency of raising the number of rules, regulations and guidelines on board, and on the ISO system of quality and ecological standards of maritime business operations. These indicators are related to the level of efficiency of the work on board.

Correlations			WEO	NR	ISO	ECO
	-	Correlation Coefficient	1,000	,045	,650**	,385**
	WEO	Sig. (1-tailed)		,288	,000,	,000
		Ν	154	154	154	154
		<b>Correlation Coefficient</b>	,045	1,000	,223**	,289**
	NR	Sig. (1-tailed)	,288		,003	,000
Seconda abo		Ν	154	154	154	154
Spearman's rho		<b>Correlation Coefficient</b>	,650**	,223**	1,000	,416**
	ISO	Sig. (1-tailed)	,000,	,003		,000
		Ν	154	154	154	154
		<b>Correlation Coefficient</b>	,385**	,289**	,416**	1,000
	ECO	Sig. (1-tailed)	,000,	,000,	,000,	
		Ν	154	154	154	154

Table 7. Correlation between administrative standard indicators and efficiency

\*\*. Correlation is significant at the 0.01 level (1-tailed). Source: Own production using SPSS

From the Table 7, it is evident that most of the indicators related to administrative factors have a significant, positive and intense impact on the efficiency of the work on board. The impact on work efficiency on board was not recorded only in relation to the number of rules, regulations and guidelines on board. Hypothesis H5 is accepted.

H6: Changing the consistency of all system factors influenced the efficiency of the work on board.

In accordance with the stated participants involved in the implementation of the standards, the indicators related to the compliance of the education system with the STCW standards, the compliance of the actual conditions on board with the STCW standards and the knowledge of the STCW standards by seafarers were explored. These indicators are related to the level of efficiency of the work on board.

	WEO	EDU	ACO	STCW		
	-	Correlation Coefficient	1,000	,425**	,424**	,057
	WEO	Sig. (1-tailed)		,000	,000	,241
		Ν	154	154	154	154
		Correlation Coefficient	,425**	1,000	,491**	,151*
	EDU	Sig. (1-tailed)	,000,		,000	,031
Concernation of the		Ν	154	154	154	154
Spearman's rho	ACO	Correlation Coefficient	,424**	,491**	1,000	,278**
		Sig. (1-tailed)	,000,	,000		,000
		Ν	154	154	154	154
		Correlation Coefficient	,057	,151*	,278**	1,000
	STCW	Sig. (1-tailed)	,241	,031	,000	
		Ν	154	154	154	154

**Table 8.** Correlation between the compliance of all system components and the efficiency of work on board

\*\*. Correlation is significant at the 0.01 level (1-tailed).

\*. Correlation is significant at the 0.05 level (1-tailed).

Source: Own production using SPSS

Given the presented results from the Table 8, it can be concluded that there is a positive, intense and significant impact of the compliance of the education system with the STCW standards and the compliance of the actual conditions on board with the STCW standards on work efficiency on board. The impact of familiarization with STCW standards by seafarers on the efficiency of work on board has not been noted. Hypothesis H6 is accepted.

#### 7. CONCLUSION

In order to present a complete framework of the research results and make conclusions, it is necessary to observe the human resources standards of maritime business in the last five years, which concerned the implementation of the STCW Marine Business Standard, which has been adapted since 2012.

The standards included the legal regulation of companies in maritime affairs, maritime labor and educational institutions. In accordance with the above mentioned factors, the indicators related to these areas of change were formed. The greatest changes were recorded about increase in the number of rules, regulations and guidelines, which had an impact on increasing oversight and positive quality changes through ISO quality system and ecological standards. In addition to this, the correction and improvement of the standards in maritime affairs concerned the raising of the quality of employees, which required a better level of health and fitness for work. By investing an extra effort from the company, it has resulted in additional encouraging of employees for training through the courses. With the increase in regulations, there has been an increase in the number of courses that employees have to attend, which has led to a mild drop in quality in the training process itself, with less attention being devoted to material resources in education, and more theoretical approach, which

moves the theory away from practice. The consequence is negative deviation that generates mild non-conformance of the education system with STCW standards which results in a further deviation of the actual condition on board from the prescribed STCW standards. It should also be noted that, although legal norms provides for a certain number of hours of rest for each employee, there is still a negative trend in practice because in certain situations on board it is impossible to achieve prescribed standards.

In accordance with the set objectives and purpose of the research, all the above mentioned is necessary to consider in the context of quality of work and work processes, as well as the efficiency of the work on board, which is the goal of improving the standards, i.e. improving the entire business of the company and achieving continuous business success. Based on the presented results, it can be concluded that increasing in number of rules, regulations and guidelines and knowledge of seafarers did not affect the quality of work and work processes and the efficiency of the work on board. There was no impact on the segment involved in the use of material resources in training seafarers at the courses. If the trend of movement of certain indicators is included in the concrete relation, it can be concluded that, despite the fact that some indicators was slightly negative, there is a positive and statistically significant correlation between seafarer's capability, administrative factors and the compatibility of different systems (educational system and business environment) with the quality of work and work processes and the efficiency of the work on board. Based on the above, it can be concluded that changes in business standards have a positive impact at improving the efficiency of the work and quality of the work processes of the maritime company. It should also be noted that the standards included in the observed research imposed by institutions outside the enterprise, which had to be implemented in last 5 years are interesting to observe considering their impact on business segments of the enterprise. As a limitation to the research it can be stated that the survey concerned solely the perceptive opinion of seafarers due to the fact that more specific indicators of business operations are impossible to access and as such impossible to measure because the business is carried out on physically remote ships. Future research should look more closely at certain segments of the business of maritime companies based on legal and administrative factors that often differ depending on national features. Another interesting area concerns training and education through courses, but also to observe the limitations of applying the prescribed standards of business.

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# **VIII. GREEN LOGISTICS**

# COLLABORATING ON GREEN LOGISTICS IN CHEMICAL SUPPLY CHAINS: INSIGHTS FROM POLAND

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#### Abstract

Sustainable, safe, secure and efficient logistics is of great importance for chemical supply chains to operate successfully. However, as most logistics operations in this sector are outsourced to logistics service providers (LSPs), chemical companies have to rely on LSPs and collaborate with them when working on logistics ecoefficiency. This paper takes an LSP's perspective. It aims to investigate the vertical as well as horizontal collaboration needed in making chemical logistics greener and safer, by shifting chemical road freight to intermodal transport, combining modes, better transport planning, and energy and emission management. The research problem is analysed on the basis of a literature review and structured, in-depth interviews conducted with nine LSPs and twelve chemical companies operating in Poland.

The research is part of the "Promotion of Multimodal Transport in Chemical Logistics" project within INTERREG Central Europe Programme. The main findings from the research show that environmental regulations and targets in the EU Transport Whitepapers have resulted in LSPs' interest to work towards establishing more ecological strategies and operations, as well as new, greener services in response to the needs of chemical companies. There are many examples of vertical cooperation, even with elements of collaboration, among LSPs and their suppliers, and chemical customers in green logistics. However, this is not the case for horizontal cooperation among LSPs operating in Poland. They consider it to be very challenging and risky, and are reluctant to share their data with other LSPs. Nevertheless, environmental regulations, technological development and efficiency goals will soon force LSPs to consider working together with other LSPs, even competitors.

The research reported in this paper is limited in its scope. Even so, it does provide a platform from which more detailed research may be conducted. The managerial implications arising from the research suggest current practices in green logistics in general and green logistics in chemical industry in particular.

**Key words:** sustainability, multimodal transport, chemical freight, Logistics Service Providers (LSPs), vertical / horizontal cooperation

#### 1. INTRODUCTION

Logistics within chemical supply chains is the integrated management of all the activities, such as freight transport, storage, inventory management, materials handling and the related information processing required to move products from a raw material source through the production and distribution system to the point of consumption and reverse direction (CSCMP, 2017). The main objective of logistics is to coordinate these activities in a way that meets customer requirements at minimum cost. In the past this cost had been defined in purely monetary terms. However, as concerns for the environment are rising, companies must now take into account the external costs of logistics associated mainly with climate change, air pollution, noise, vibration and accidents. In the European Union (EU) the negative effects of logistics have been estimated at more than 250 billion EUR annually (Woxenius and Barthel, 2013). A significant part of it comes from transport, in particular road freight transport.

This article concentrates on transport operations in chemical supply chains. The European Commission (EC) warns that transport represents almost a quarter of Europe's greenhouse gas emissions (GHG) and is the only major sector in the EU that has not seen the same gradual decline in emissions as other sectors. Within the transport sector, road transport is by far the biggest emitter, accounting for more than 70% of all GHG emissions from transport in 2014 (European Commission, 2016). It is also the main source of traffic congestion, noise, vibrations and accidents, which impacts not only environmental but also the social and economic performance of the EU.

Bearing this in mind, while designing the European transport policy for the 21<sup>st</sup> century, the EC aimed to "disconnect mobility from its adverse effects" (COM, 2001). In compliance with the Kyoto Protocol (EEA, 2005), the EC aimed to reduce GHG emissions by 20% below 1990 levels by 2020, and by 80-to-95% by 2050. In order to achieve these objectives, the EC wants to shift 30% of road freight, transported more than 300 kilometres, to multimodal by 2030 and to 50% by 2050, revitalize rail transport, and improve short-sea and inland waterways, among others (COM, 2011).

Transport and logistics industries are working on achieving these goals and making transport more sustainable with a strong commitment and contribution from chemical companies, who transport large volumes at long distances and recognize environmental and social sustainability as a strategic priority (WEF, 2009; Cefic, 2014). In regards to Central Europe, the chemical industry is an important economic sector with 117 billion EUR turnover and 340.000 employees.<sup>1</sup> However, as most logistics operations in the chemical sector are outsourced to logistics service providers (LSPs) (McKinnon & Piecyk, 2010, p. 14), chemical companies have to rely on LSPs and collaborate with them to improve the safety and environmental protection of chemical transports, while at the same time ensuring competitive and economically feasible solutions.

This paper takes an LSP's perspective. It aims to investigate the vertical as well as horizontal collaboration in making chemical logistics greener and safer by shifting chemical road freight to multimodal transport, greater use of intermodality when

<sup>&</sup>lt;sup>1</sup> http://www.interregcentral.eu/Content.Node/ChemMultimodal.html

transporting chemical products to and from manufacturing plants, better transport planning, and energy and emission management in chemical supply chains.

The remainder of this paper is organised as follows. It starts with the introduction, which is followed in section 2 by a literature review, where two main topics are covered: green and sustainable logistics concepts, as well as supply chain collaboration on green logistics and transportation. This section provides the theoretical basis of the work. In section 3, the ChemMultimodal project and research methodology are presented. In section 4, the findings are presented and a discussion is organised around three topics: CO2 emission management, road freight transport shift to multimodality and collaboration on multimodal transport. The paper ends with conclusions and suggestions for future research.

#### 2. LITERATURE REVIEW

The literature review is used to frame the analysis. It focuses on two main topics: (1) green logistics presented firstly as a function, next as a part of corporate strategy and finally from the supply chain perspective, and (2) LSPs' collaboration on making logistics greener and more sustainable.

#### 2.1. Green logistics and sustainability

Green logistics is related to reducing environmental impact from different logistics operations, i.e. mainly freight transport, but also storage, inventory management, materials handling, or reverse logistics. While green logistics encompasses a wide variety of dimensions and initiatives, companies that focus only on one specific dimension (e.g. freight transport) could still be seen as implementing green logistics.

In the 21<sup>st</sup> century, interest in environmentally responsible logistics operations has increased. This has been a result of governmental regulations, economic considerations, and increasingly strong market signals from environmentally conscious consumers (Goldsby & Stank, 2000; Scholtens & Kleinsmann, 2011; Tacken et al., 2014). However, it should be recognized that the motivation towards greener logistics operations have been also found by companies internally. Rossi et al. (2013) have pointed out the growing role of cost reduction, quality improvement, and the personal commitment of a leader, as well as middle management involvement, as main drivers of green logistics. Evangelista et al. (2017) have expanded the list with, broadly discussed in literature, the willingness to improve corporate image.

After the stage of focusing on green logistics as a function and ad hoc reactive eco initiative, the environmental sustainability of logistics has become the new priority for logistics managers and part of corporate strategy (McKinnon, 2015). Managers have aimed at making logistics more sustainable, i.e. organizing it in the way that allows for meeting the needs and goals of the present, without compromising the ability of future generations to meet their own needs and goals (Brundtland Commission, 1987). It should be stressed that green logistics as a part of corporate sustainable strategy is not limited just to an environmental dimension. Sustainability means the reconciliation of environmental, economic and social objectives at the same time. It is about eco-efficiency and social responsibility of logistics. In literature the term eco-efficiency is defined as the "reduction of resource intensity and minimisation of environmental impacts (...) with value creation" (Rossie et al., 2013). In other words, it is doing more with fewer resources, and saving CO2 and money.

To improve corporate logistics performance, a large portion of companies, whose core competencies focus on functions other than logistics, have decided to outsource their logistics operations to LSPs (Selviaridis & Spring, 2007) what is also the case for the chemical industry (McKinnon & Piecyk, 2010, p. 14). Increase in the outsourcing of logistics services and intense competition in the 3PL market has led to a broadened scope of services offered by LSPs, aiming to satisfy the requirements of a wide range of customers (Busse & Wallenburg, 2011, Cichosz et al., 2017). including environmentally conscious customers. According to Martinsen & Huge-Brodin (2010), the development of green logistics services is an active interface between the demand and supply side, where both sides place pressure on, and respond to, each other. Research conducted in the European chemical industry by Leppelt et al. (2011) shows that the influence of a purchasing company (shipper) on logistical variables related to sustainability is significant. Sustainability leaders intensely invest in sustainable supplier relationship management practices, such as code of ethics, in order to manage sustainability even beyond their corporate boundaries. Research conducted by Rogerson (2017) proves these findings and presents three causes of influence on the shippers' purchasing processes based on logistical variables: specific requirements, network structure of transport providers, and scope of contract. Specifications by purchasers, especially time requirements, influence several logistical variables defined earlier by Piecyk & McKinnon (2010) such as 'mode used', 'length of haul', 'load factor', 'empty running', and 'fuel efficiency', which are, in turn, related to CO2 emissions.

Some can ask the question if further efficiencies in green logistics are possible. McKinnon et al. (2015), analysing improvements that have been made, admit "the potential still exists to cut the other environmental costs of logistics by a significant margin." Lieb & Lieb (2010) in their study of LSPs' CEO foresee that "green management and integrating green issues into logistics service offerings has involved more and more LSPs and will probably attract even more managerial attention in the logistics industry in the future." However, to achieve further efficiencies, a broader perspective on environmentally responsible logistics is required. Companies have to realize that an individual firm's environmental impact extends well beyond its corporate boundaries, and collaboration on green logistics becomes a must.

The thesis that supply chain partners' collaboration on green logistics can help to address the challenges related to modal shift, was formulated on the base of Resource Based View (RBV) and Social Exchange Theory.

#### 2.2. LSPs' collaboration on green logistics

The fundamental rationale behind collaboration is that a single company cannot successfully compete by itself as customers are more demanding, less loyal, and competition is escalating. Thus, the ability to compete has been directly linked to the ability to collaborate with supply chain partners. Firms enter into interfirm collaborative arrangements in order to share risks and rewards. The objective is to secure higher performance than would be achieved by operating individually (Lambert et al., 1999).

When designing supply chain collaboration on green logistics, three elements are playing key role: the appropriate partner you collaborate with (i.e. customer, supplier, competitor, etc.), the plethora of green logistics activities constituting the 'width' of green logistics collaboration, and the level of supply chain collaboration referred as the 'depth' of the relationship.

#### 2.2.1. The concept and directions of supply chain collaboration

In this paper supply chain collaboration is understood, according to Soosay and Hyland (2015), as: "two or more companies working together to create a competitive advantage and higher profits than can be achieved by operating alone". However, not all cooperation is collaboration. Świtała (2015) grades inter-firm relationships on a scale from cooperation (the basic level of supply chain integration), through to coordination (with a higher level of integration), up to collaboration (when companies treat each other as an "extension" of their organization).

It is widely accepted today that supply chain collaboration enables superior performance in firms due to the capitalization on resources, capabilities, processes and routines residing in their partners' firms (Fawcett et al., 2012). Among the main benefits companies name efficiency (e.g. cost reduction, reduced inventory, shortened lead-time, streamlining supply chain process, etc.), effectiveness (improved customer service and customer satisfaction, increased market share, increased sales, new product development, etc.), and profitability (Min et al., 2006; Kohli & Jensen, 2010).

The competences of LSPs make them an attractive partner for logistics collaboration. Collaboration with LSPs has a positive effect on the efficiency of logistics performance, which translates into the increased competitiveness of the supply chain. The LSPs and chemical companies collaboration within the supply chain was investigated during studies commissioned by Cefic and EPCA (chemical industry associations) (Cefic, 2004 & 2005). The main conclusion from the studies was that there is a need for increased collaboration to eliminate waste and create value. Working groups emphasised that "shippers (chemical companies) must understand their core role in logistics processes and cannot just expect providers to take the initiative from their current position. (...) The industry should develop new capabilities and working methods to collaborate with LSPs" (Braithwaite (ed.), 2005, p.3).

The supply chain collaboration of LSPs and their partners may have two directions, i.e. vertical and horizontal. **Vertical collaboration** refers to collaboration between adjoining businesses i.e. the LSP and customers (shippers) on the demand side, as well as suppliers, rail and port operators on the supply side. **Horizontal collaboration** refers to partners with a similar business profile, which operate at the same tier of the supply chain and very often decide to share logistics capacity. According to Barratt (2004), they could be competitors or non-competitors. This form of relationship is often called cooperation takes place for non-core activities such as

transport and logistics (Cruijssen, 2012). Soosay et al. (2008) refers to reduced logistics and administration costs for individual organizations, improved procurement terms, and lowered fixed costs of indirect labour as main incentives for integrating horizontally. Wallenburg and Schafller (2016) admit that horizontal collaboration is a common practice among LSPs who form partnerships to increase the productivity of their assets or extend their geographical coverage by combining a network of LSPs.

Simatupang & Sridharan (2002) have observed that while aiming at gaining more flexibility, LSPs combine both vertical and horizontal collaboration. This kind of thought-process and action is referred as **lateral collaboration**. The logistics examples of lateral collaboration are integrated logistics and multimodal/intermodal transport, aiming at synchronizing the carriers and shippers of different firms in a seamless and effective freight transport network when at the same time cooperating with other LSPs to improve efficiency of logistics.

When the parties involved in the logistics collaboration are located in close proximity, we talk about **logistics clusters**. According to Sheffi (2012) they embrace: (i) logistics service companies or (ii) companies with logistics-intensive operations who compete based on their logistics prowess, and (iii) the customers of logistics services i.e. chemical companies. Naturally, many logistics clusters develop around transportation hubs, such as mode-changing terminals.

#### 2.2.2. Framework for green logistics collaboration

Green logistics initiatives, which are the subject of green collaboration, may be defined as "the set of actions and decisions necessary to mitigate the negative impact on the environment derived from activities carried by company" (Klassen & McLaughlin, 1996). Nowadays, they are more often taken into account when purchasing logistics services (Martinsen & Bjorklund, 2012).

Evangelista et al. (2017) propose taxonomy, distinguishing two different types of environmental initiatives. On one hand, there are initiatives mainly focused on green solutions that are predominantly effective within the boundaries of an LSP company (called 'point' initiatives), related to e.g. the vehicle, its age, engine type, fuel, eco driving, loading factor, use of IT, etc. On the other hand, there are green actions that extend their impact beyond the boundaries of LSP (called 'supply chain' initiatives), which demand partners' collaboration on planning, organizing and controlling. They include among others:

- shifting road freight transport to a multimodal transport understood here as the carriage of goods by at least two different modes of transport when the main part of products journey is done by an environmentally friendly mode on the basis of a multimodal transport contract (Cichosz et al., 2017),
- greater use of **intermodality** (the usage of one loading unit during the whole journey of freight what demands infrastructure planning, and coordinating leasing of equipment, inspections, cleaning, mending and empty stacking of intermodal loading units among others),
- collaborative transport planning for routes and fill-rates optimization, and

energy and emission management by introduction of environmental management systems (e.g. ISO 14001), emission off-set programmes, using lower energy transport modes, renewable energy etc.

Some of these initiatives are managed in dyadic relationships (LSP vs. supplier or LSP vs. customer), while the others need multi-partner collaboration. The latter were found to be more demanding and underdeveloped (Evangelista et al., 2017), and thus offering higher potential for efficiency, including eco-efficiency.

#### 2.2.3. Intensity of supply chain collaboration

Collaboration is challenging and costly, which means that it is not for all supply chain members. Lambert et al. (1999), Barratt (2004), Soosay et al. (2008), Cruijssen (2012) and many others suggest that segmentation is needed for selecting a small number of strategically important customers and suppliers worth collaborating with.

Lambert et al. (1999) have identified three types of cooperation (the model was adopted by Cruijssen in 2012 with three types of collaboration specifically in transport services) depending on the level of integration between partners. According to Cruijssen (2012) **type I** consists of mutually recognized partners that cooperate to a limited degree within a short time horizon. **Type II** – participants that do not merely coordinate, but also integrate part of their business planning. The horizon is longer, and multiple divisions or functions of the companies are involved. **Type III** is when participants have integrated their operations to a significant level and each company regards the other(s) as an extension of itself. This business relation is based on mutual trust, openness, shared risk and shared rewards. Typically, there is no fixed end date for such collaboration. This spectrum of relationships is completed on the left side by an arm's length (transactional) relationship and on the right side by full integration.

Planning for environmental goals extending beyond single company boundaries and involving multiple supply chain partners needs intensive collaboration, as very often it results in supply chain reconfiguration.

#### 3. RESEARCH ON GREENER TRANSPORT OF CHEMICAL COMPANIES

As freight transport represents the largest portion of costs and emissions within the framework of logistics operations, research on green logistics of chemical companies is focused on green transport operations.

#### 3.1. Transport challenges in chemical supply chains

Describing chemical freight transport, it should be emphasized that it differs between upper and lower end of supply chain. In the upper section of supply chains, primary producers of base chemicals transport their products mainly in bulk volumes that can fill a full road vehicle, barge, ship, wagon and even a whole train. Thus, on the inbound logistics side, chemical companies make use of lower carbon modes such as pipeline, rail and water-bone services. Further down the supply chain, the nature of transport operations changes as the portion of packaged chemical products increases, average order size declines, and the average number of drops per delivery increases, which results in the growth of a significant use of road transport. Applying rail transport in the lower part of supply chain requires more planning, but it is still feasible as chemical packaged products are characterized by relatively high density.

The priority for transport operations in chemical supply chains is safety and security. Product safety refers to the reduction of the probability that use of it will result in negative consequences on customers (which are from a wide spectrum of sectors as chemicals are incorporated into a broad array of products). Product security refers to the delivery of a product that is uncompromised by intentional contamination, damage, or diversion within the supply chain (Marucheck et al., 2011). Safety and security are named as qualifying criteria when purchasing logistics services. Eco aspects are just now gaining attention from chemical companies (Evangelista et al., 2017; Martinsen & Bjorklund, 2012).

The challenge to arrange and coordinate multimodal transport with rail, waterbone or sea (where applicable) as main haulage is addressed to logistics providers, as almost all transport operations of chemical companies (except pipeline movement) are outsourced (McKinnon & Piecyk, 2010). Chemical companies employ a full range of logistics companies, with a full range of transport modes. The density of chemical products is relatively high and the chemical industry generates a high portion of full loads, which makes the chemical industry a perfect shipper for massive transport modes, and shift to multimodal.

#### 3.2. ChemMultimodal project - response to environmental challenges

The ChemMultimodal project aims to promote the multimodal transport of chemical goods in Central Europe. Regional authorities, chemical industry associations and scientific institutions from seven regions in Central and Eastern Europe are working together to improve safety and environmental protection of chemical transports on the one hand, but also to ensure competitively and economically feasible solutions on the other.

The project partners want to support chemical and logistics companies in their ambitions to shift transport from road to multimodal. The chemical industry is an important stakeholder responsible for 8 percent of freight transport in Central Europe and significant user of multimodal.

The European Union has defined targets for the increase of multimodal transport in the upcoming years. Actions to reduce the CO2 footprint have a high political priority at global, European, and national levels. Multimodal transport is often crossborder transport – therefore harmonization challenges are very important to ensure sound framework conditions. Nevertheless, reality has shown insufficient progress for the modal shift, caused by infrastructure bottlenecks or high competition from road transport.

The project is running from June 1<sup>st</sup> 2016 to May 31<sup>st</sup> 2019. It is divided into six stages. The main objectives for the first two stages were: (1) analysis of the current situation of the intermodal transport of chemicals, and (2) development of a toolbox for chemical road freight transport shift to multimodal, in particular rail.

#### 3.3. Research methodology

The research problem is analysed on the basis of a literature review and structured, in-depth interviews conducted in 2016 with twelve chemical companies operating in Poland and nine LSPs serving them.

#### 3.3.1. Instrument development

A questionnaire for in-depth interviews was developed in English as a guide for the whole project and was later translated into Continental languages of project partners. The questionnaire included a mixture of open and multiple-choice questions. It comprised of the following sections:

- Relevance of CO2 measurement 1.
- 2. Importance and main routes of multimodal transport
- **3.** Potential for modal shift
- 4. Drivers (advantages) and barriers (disadvantages) of modal shift
- 5. Potential internal and external improvements in modal shift (with emphasis on vertical and horizontal collaboration with supply chain partners).

A pilot test was performed with an expert in the field of logistics and supply chain management in chemical company, before the full sample of respondents were interviewed. It allowed for the avoidance of misunderstandings.

#### 3.3.2. Data gathering

The questionnaire was sent out to forty-nine companies across Poland. Logistics and supply chain managers were found as the most suitable informants. Twenty-one managers responded and interviews were performed by telephone and at-company sites from August to September 2016, and lasted approximately one hour each. Statistical data was completed by e-mail. Finally, 21 questionnaires were collected: nine from logistics companies (LSPs, carriers, rail and port operators) and 12 from chemical companies (producers and distributors as well). Both groups of respondents were rather diversified, 45% of logistics companies were big players with more than 250 employees, 22% were medium sized players, and 33% were considered as small logistics companies. The split of chemical companies was as follows: 58% - big, 25% - medium, and 17% - small players (Figure 1).

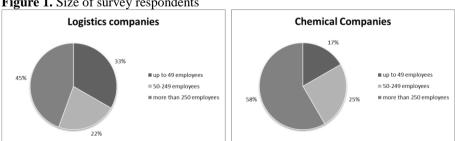
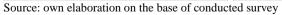


Figure 1. Size of survey respondents



#### 4. FINDINGS AND DISCUSSION FROM POLAND

As generally most logistics operations within chemical supply chains are outsourced to logistics companies, the analysis of the results of the survey are performed from the perspective of LSPs (although in some aspects the other perspective is also included). The analysis is organized around three main topics: CO2 emission management, road freight transport shift to multimodality and collaboration on multimodal transport.

#### 4.1. CO2 emission management in chemical transport

One of the main goals of ChemMultimodal project is to reduce CO2 emissions from European chemical transport and this way making it greener. Therefore, it was important to diagnose the current status of CO2 footprint measurement practices within chemical and logistics companies, and learn if there is willingness among partners in chemical supply chains to improve the situation.

The results of the survey show that in Poland **the interest in CO2 measurement is rather low among chemical and logistics companies**. The situation looks a little bit better among big logistics players, who introduced sustainable programmes and sustainable organisational culture, resulting in their employees being environmentally conscious while having the equipment and procedures to do it. These logistics providers measure and report on the CO2 footprint for different groups of their stakeholders, including their customers who can receive emission data on their invoices. To estimate CO2 emissions, logistics companies apply CO2 calculators, calculating emissions using energy consumption data. A very popular web-based CO2 calculator among big logistics players is EcoTransIT.

Medium and small logistics companies, as the reasons for low interest in emissions measurement, most frequently cite: 'the lack of obligatory requirements for transport emission reporting', and 'no equipment and procedures for emissions' measurement'. Respondents from chemical companies point out the other two aspects that cause their disinterest in measuring emissions. Firstly, most of their emissions come from the production process and their sustainability programmes are focused on reducing emissions from production. Secondly, they outsource transport and logistics to LSPs thus, in their opinion, emissions from transport and logistics are not their problem. They have already paid for it.

Concerning the change in the approach to CO2 and other emissions' measurement, it is worth noticing that respondents admitted that as long as they would not see advantages or would not be obliged to measure and reduce emissions, they might not be particularly interested in changing their behaviour in this field. And according to the rule 'if you do not measure it, you cannot manage it', their interest in operations helping to reduce CO2 emission i.e. modal shift, more efficient planning of transport routes, backloads, and improvement of a fill-rate factor or efficiency of terminal operations, etc. would stay rather low.

#### 4.2. Multimodal transport in chemical supply chains

The results of the survey show that multimodal transport is applied in chemical supply chains. However, it is considered more important for logistics companies than for chemical ones. These evaluations correspond with chemical companies' multimodal transport share, which is relatively low in relation to other modes of transport. The bad news is that, in general, respondents from chemical companies in Poland do not see a specific motivation to increase multimodal transport usage. They acknowledged that they organize transport on the base of cost and convenience. They are not interested in CO2 emissions. Shorter transit time and better cost are arguments that could motivate them to use multimodal transport more intensively. However, regarding transit time, in most cases logistics companies are not able to satisfy chemical companies' expectations with multimodal transport within the framework of contemporary European transport system with its low interconnectivity and interoperability (Cichosz et al, 2017). In this case **the real motivation to shift chemical road transport to multimodal is safety and security, as well as necessity to carry higher tonnages**.

Main routes for multimodal transport in Poland are hinterland connections from/to Polish ports Gdańsk/Gdynia, Szczecin/Świnoujście, as well as from European ports, such as ARA (Antwerp, Rotterdam, Amsterdam) and Hamburg, to central Poland and Upper Silesia. Respondents see the biggest potential to shift road transport to multimodal in hinterland connections from/to Polish ports and from their factories to Spain, Italy, Germany, Romania and Turkey.

Identifying essential factors which support the promotion of multimodal transport within the chemical industry, both chemical and logistics companies pointed out lower transit costs over long journeys and safer transit for dangerous, hazardous products. Logistics companies, analysing drivers of modal shift, paid more attention to environmental issues. They admitted that the usage of multimodal solutions supports their CSR strategies, as well as contributes to emission reduction of greenhouse gases, noise, fumes and vibrations. However, to be efficient, they see the need for close collaboration with other chemical supply chain partners.

#### 4.3. Collaboration on multimodal transport in chemical supply chains

The results of the survey with a discussion regarding collaboration on greener freight transport in the chemical industry are presented from three perspectives: a vertical, a horizontal, and a lateral one.

#### 4.3.1. Vertical collaboration

Regarding vertical collaboration, all respondents from logistics companies admitted that they cooperate with their customers, however the intensity of the cooperation between companies differs. Big logistics players have a few significant customers with whom they integrate selected logistics processes, work on new routes (including intermodal connections), new packaging or extra services tailored to their needs, e.g. terminal services related to cleaning railway cars. This cooperation has elements of collaboration. However, it is the minority. The logistics market in Poland is very fragmented and the majority of logistics companies are small players with very limited market power. That is why they generally cooperate with their customers at arm's length with very limited trust. In the case of arm's length cooperation, partners are not ready to allocate the risk related to a shift from road to multimodal transport. They instead focus on time and cost efficiencies.

Regarding chemical companies, two out of 12 respondents decided to outsource their freight operations to LSPs, three out of 12 prefer to organize freight transport on their own, three work in cooperation with LSPs, and the last four apply the mixed model with few routes managed by chemical companies' transport departments on their own, and the others are managed by LSPs. The share of operations managed independently against these managed by LSPs differs from company to company.

In regard to collaborating with suppliers with access to infrastructure, equipment and services (including IT services), LSPs see the potential in it and aim to further utilize these relationships. Information and Communication Technology (ICT) is seen as an enabler, which helps LSPs to cross organizational boundaries. In the beginning, ICT was mainly used to support existing inter-organizational processes (e.g. the exchange of documents) whereas now the trend is on the emergence of new ways to do business with supply chain partners (e.g. electronic auctions).

#### 4.3.2. Horizontal collaboration

On the other hand, LSPs' horizontal collaboration is very limited in Poland. Respondents from logistics companies admitted that their cooperation with competitors, and non-competitors operating at the same tier of the supply chain, is extremely difficult. The biggest challenge is openness and trust, and fair gain and risk sharing. Shortages in these aspects make transport services organized by several providers not transparent to customers. This type of cooperation needs improvement, as LSPs are aware of the advantages of horizontal collaborations in terms of cost, efficiency, customer service, market position and others. LSPs understand that, individually, it could be difficult for them to shift transport from road to rail but when consolidating shipments from different LSPs it could be feasible to fill the train. It should be emphasised that nowadays ICT enables inter-firm communication and facilitates the process of horizontal collaboration. Thanks to IT solutions logistics companies could develop knowledge and recognition of capacities and capabilities of fellow LSPs (e.g. specialised in other core areas than their own) and make use of it.

Horizontal cooperation, even with elements of collaboration, in the light of the European regulations, environmentally conscious customers' requirements and the eco-efficiency goals, could soon become a must solution allowing for an increased scale of operations.

#### 4.3.3. Lateral collaboration

Consolidating shipments in order to achieve the volume of transport to qualify it for multimodal or intermodal shipments requires both types of collaboration i.e. vertical (with customers, carriers, rail and terminal operators etc.) and horizontal (among LSPs) as well. This type of collaboration is referred to as a lateral one.

ICT solutions available on the market could facilitate the collaboration process. Many information tools such as rail maps, terminal maps, schedules with regular rail connections, etc. are already available free-of-charge. However, as the results of the survey show, logistics and supply chain managers of logistics and chemical companies do not know and use them. When planning transport, most of them uses information systems that are integrated just within their company what does not help them to collaborate on consolidating shipments across companies. Nevertheless, the results of the survey show, that situation is slowly changing. Several logistics companies (more often big players) are connected to their suppliers and/or customers, and very low proportion of LSPs is even connected to other LSPs. The results of the survey show that LSPs prefer to cooperate with other LSPs through fourth parties such as e.g. a railway operator who operates regular connections and consolidates shipments for them such as PCC Intermodal.

#### **5. CONCLUSIONS**

This paper addresses the topic of collaboration on green transportation with LSPs and chemical companies by using a sample of 21 in-depth interviews conducted in Poland.

**From a theoretical perspective**, this study enriches the existing body of knowledge by looking at the supply chain collaboration on green logistics through the perspective of an LSP, who is actually not a supply chain leader in chemical supply chains. However, as most logistics operations in the chemical industry are outsourced to logistics service providers, LSPs play core role in improving safety, competitiveness, as well as eco-efficiency of chemical transports and other logistics operations.

The discussion within the paper is focused on reducing the negative impact of chemical transport by introducing to the supply chain green initiatives extending beyond the boundaries of LSP, i.e. organising for multimodal transport, greater use of intermodal transport, and energy and emission management. Within the literature review the horizontal cooperation among adjoining LSPs is emphasised as one which is gaining more and more attention from academics and logistics practitioners as well, and which is giving opportunities for achieving further efficiencies.

This study makes a number of **contributions to practice**. It proves that the ability to compete in chemical transport has been directly linked to the ability to collaborate. It suggests that LSPs should focus not only on vertical but also horizontal collaboration. The study proves that to collaborate with other logistics companies, LSPs should develop a better knowledge and recognition of the capacities and capabilities of fellow LSPs, which could be easier with the support of industry-wide IT platforms.

Within the ChemMultimodal project, partners from seven regions across Central Europe are working on a tool which is aimed at facilitating chemical supply chain partners' collaboration. The tool embraces: (1) IT visualisation of multimodal

transport infrastructure, (2) planning guidelines for increasing multimodal transport, (3) consulting services to improve multimodal transport, and (4) measuring the CO2 footprint. Tests of the tool with selected chemical companies in seven regions across Central Europe will start in mid-2017.

This study presents some limitations. The main one relates to the small number of investigated companies. To achieve empirical generalisation, it would be necessary to increase the number of case studies. Moreover, further research is needed on vertical collaboration in multimodal transport, within logistics clusters developed around inland logistics terminals and ports. It would be interesting to take a deeper look at the problem from the perspective of the process itself, and by using IT tools to support planning for multimodal transport collaboration.

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# INITIATIVES AND PRACTICES FOR GREENING LOGISTICS SERVICES ON THE POLISH MARKET – STATUS QUO AND DEVELOPMENT OPPORTUNITIES

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#### Abstract

The practice provides us with numerous examples of green initiatives and solutions being implemented by logistics service providers (LSP). They differ from one country to another and their complexity and sophistication depend to a large extent on the development and state of maturity of the logistics market in a particular country. The factors that may influence the adoption of such green solutions were examined in several studies and the problem was investigated from different perspectives (LSP, customers, forwarders). However, there is a lack of research and publications referring to the Polish logistics market within the "green" context. Greening the logistics services seems to be overlooked or neglected.

Therefore, the main purpose of this paper is twofold: 1) to elaborate the scope and types of green initiatives and best practices implemented by LSPs on the Polish market, 2) to examine the factors behind the (non-)implementation of green solutions by LSP acting in Poland. In order to achieve these goals, the authors scrutinized the Polish logistics market as well as conducted a survey among logistics providers and freight forwarders acting in Poland. The green initiatives and green practices identified were subsequently organized and classified according to a comprehensive taxonomy (e.g., initiatives resulting from regulatory instruments of environmental policy *vs.* voluntary initiatives; green activities offered on a daily basis *vs.* those performed only as a special request from a customer). Moreover, the authors also elaborated on the formal system of green certification (e.g., ISO 14001 or BREEAM).

**Key words:** green initiatives and practices, green logistics; green transport; Logistics Service Provider, logistics services market

#### 1. INTRODUCTION

Environmental issues have emerged as a crucial area in development strategies of many transport, logistics and forwarding (TFL) companies. Introducing green solutions in their daily activities is perceived as a company's social responsibility and is seen in a positive light and welcomed by society. Green efforts may lead to a reduction in external cost of transport and logistics activity and simultaneously be profitable for a company.

The issue of environmental impact of TFL activity should not be overlooked, because the TFL sector as a backbone of international trade and globalisation contributes noticeably to global pollution and air emissions. According to the European Environmental Agency, the EU transport sector is still responsible for 46% of total EU-28 emissions of NO<sub>x</sub> and constitutes a rising source of GHG emissions that in 2015 exceeded 1990 levels by 21%. (EEA, 2016, pg. 18) Furthermore, it is also projected that along with rising volumes of transported cargoes, CO<sub>2</sub> emissions from global freight could increase by 160% if no reduction measures are taken. (ITF, 2017, pg. 13).

The rising importance of environmental issues in the TFL sector is even reflected in the well-known Logistics Performance Index (LPI) and its indicators introduced by the World Bank. In 2012, for the first time, the LPI started to refer to green issues in logistics and survey the demand for environmentally-friendly international logistics (The World Bank, 2016, pg. 35).

Generally, while analysing green practices, attention is given more to manufacturing companies than to TFL ones; however, studies within the area of green logistics are progressively increasing. The problem researched from different perspectives often concerns experiences of LSPs in particular countries, especially Asian ones (e.g., Lin & Ho, 2011, pgs. 67-83). However, we noticed a lack of research in this field with regard to a Polish context and there are clear grounds to elaborate this topic due to the rising importance of the Polish TFL market.

The Polish TFL market is relatively young when comparing to markets of Western European countries. It has continuously developed since the beginning of the 1990s alongside with the process of transformation of the Polish economy to the market rules and further accelerated in 2004 after joining the EU. Simultaneously, at a European level, this is also quite a big market. According to data provided by the acknowledged German Fraunhofer Institut, in 2015 the size of the Polish TFL market was estimated at EUR 53.4 billion, which ranks Poland as the 7th biggest in Europe. (Kille et al., 2015, pg. 29) Considering exclusively the road transport market, the rank of Poland is even higher. (Raczkowski et al., 2017, pgs. 14-16) Furthermore, taking into account the total volume of the modern, commercial warehouse spaces (more than 11.2 million m<sup>2</sup> and this is forecasted to double over the next ten years), the Polish market resources rank eighth in Europe (JLL, 2016, pg. 32). The central location of Poland in Europe, the even better condition of its transport infrastructure and location of Special Economic Zones in particular regions are, among others, factors influencing the development of the Polish TFL market and confirming its rising importance.

For this reason the environmental issues (environmental problems, general attitude to green practices and green practices/initiatives per se) regarding this particular market cannot be disregarded (neglected) as it has a wider resonance and influence to some extent the whole TFL sector and its pursuit to being eco-friendly.

Therefore, the purpose of the paper is twofold: 1) to elaborate the scope and types of green initiatives and best practices implemented by LSP on the Polish market,

2) to investigate the factors behind the (non-)implementation of green solutions by LSP acting in Poland.

This research is part of an ongoing project on the state of green transport and logistics in Poland. The first part of the project focuses only on one particular step in the transport/logistic process, namely the purchasing of TFL services and these results were published in Klopott and Miklińska (2016, pgs. 1-6).

# 2. METHODOLOGY

In order to accomplish the purpose of this paper, we decided to conduct three steps of research. First, with the aim of identifying what green initiatives and practices have been adopted by LSPs operating in Poland, we chose the method of content analysis. Krippendorff defined this method as, "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the context of their use" (Krippendorff, 2012, pg. 24). We selected for this analysis the 62 largest TFL companies (with respect to volume of revenues in 2015), which are included in the most recognized ranking of TFL companies operating in Poland, prepared by prof. H. Brdulak on a yearly basis (Brdulak, 2016, pg. E4-E5). They include both global, well-known logistics companies, and domestic ones, which offer services at national and international levels. All their websites, newsletters as well as companies' reports were explored in search of information about their green initiatives and practices.

The second step of the research we devoted to a survey among freight forwarders and logistics providers acting in Poland aiming at identifying factors underlying (non)implementation of green practices, LSPs' attitude to greening their services as well as green activities. We created a questionnaire using a form template provided by Google Forms and we also used this tool for distributing the questionnaire as well as for collecting answers. We sent the questionnaire to members of the Polish International Freight Forwarder Association (it was also included in their weekly newsletter) which embrace not only the biggest companies on the TFL market, but also the medium-sized and small ones. It allowed us to enrich this research as it was noticed by Lieb & Lieb (2010, pg. 524) that a majority of papers on green strategies of LSPs are mainly focused on large companies and the green attitude of mediumsized LPSs is generally not sufficiently researched (Oberhofer & Dieplinger, 2014, pg. 236).

Although the survey started in October 2016, we were still receiving new responses until the end of April 2017. The first part of the survey questions was dedicated to the phase of purchasing and offerings of green TFL services and the initial results were evaluated and published (Klopott & Miklińska, 2016, pgs. 4-6). The second part, on the other hand, was designed to examine green practices on the Polish TFL market as well as the factors behind their (non-)implementation.

In the third step, four of the targeted companies were interviewed in-depth in order to enrich the survey results, as the response rate was lower (29%) than we originally envisaged. These included the Polish branch of the global LSP, two medium-sized LSPs and one national freight forwarder company.

# **3. RELATED WORK ON THE FACTORS INFLUENCING THE ADOPTION OF GREEN SOLUTIONS**

The issue of adoption of green practices by companies from the TFL sector may be analysed from different perspectives: LSP, customer, forwarding or transport company. The majority of studies investigates this problem from the perspective of an LSP operating on a particular market (e.g., Abdullah R. et al., 2016, pgs. 82-85), much less frequently from the perspective of a customer, particularly within the context of green purchasing and offerings (e.g., Martinsen & Björklund, 2012, pgs. 562-583). Environmental sustainability is frequently recognised as a priority in strategies adopted by many companies. However, Evangelista et al. (2014, pg. 65) draw attention to the fact that there is a difference in involvement of TFL companies in green initiatives which correlates with the range of their services as well as general attitude to environmental issues.

There are a number of factors which may influence the adoption of such green solutions and they have been investigated in several studies. Lin and Ho (2008, pgs. 17-26; 2011, pgs. 67-83) examined factors influencing the adoption of green practices in the Chinese logistics industry and indicates their three dimensions: technological, organizational (e.g., the quality of human resources and the accumulation of greenrelated knowledge) and the external environment in which a company conducts its business. Some authors claim that the trend of introducing green practices on a voluntary basis is increasing, because companies believe that it may have a positive influence on environment and sustainable development (Lai et al., 2010 pg. 7). Fürst and Oberhofer (2012, pg. 70) suggest that an increasing number of 3PLs perceive environmental sustainability as an opportunity to improve competitiveness and reap economic benefits. In the same vein, Zhu et al. (2008, pg. 261) point out that integrating environmental concerns into logistics activity translates into gaining and maintaining a competitive advantage. On the other hand, it is not always the case that implementation of green practices results in both: reducing the environmental impact and achieving profits and market share objectives (Zhu et al., 2007, pg. 1043). The other principal factors behind implementing green practices that are often referred to are customers' requirements and pressure from the supply chain (Zhang et al., 2008, pg. 1036), as well as governmental and international laws and regulations. Rising environmental awareness among the employees at all levels is another key driver for implementing green initiatives (Zhu et al. 2007, pg. 1043; Isaksson & Huge-Brodin 2013, pg. 217) what may translate into "greening" as part of a company's culture.

# 4. GREEN INITIATIVES AND PRACTICES - IDENTIFICATION AND ANALYSIS

Findings derived from the content analysis, survey questionnaire and interviews allow us to identify and subsequently classify and elaborate the environmental practices of investigated TFL companies.

Table 1 provides a general classification of identified green initiatives and practices that have been divided into seven basic categories (coded here from A to G).

It should be noted that there might be some overlap between the categories and that a particular practice/initiative may belong to more than one category. Throughout the rest of the article individual initiatives may be assigned multiple codes, including two codes belonging to the same category.

CODE	CATEGORY	DESCRIPTION	
A1	Obligatory	Activities resulting from regulatory instruments of environmental policy.	
A2	Voluntary	Activities which: are part of a company's culture; result from the green strategy of a company; may be introduced in anticipation of new environmental regulations.	
B1	Linked to non- operational activities	Green solutions without direct correlation to the offered services and implemented regardless of customers' requirements.	
B2	Linked to operational activities	Green solutions integrally related to the offered services, either adopted as internal standards, or offered to customers upon request.	
C1	Requiring substantial financing	Activities and solutions which require considerable financial investment in assets or human capital.	
C2	Not requiring substantial financing	Solutions which can be put into effect without incurring considerable expenses.	
D1	Ad hoc and informal	Activities and solutions that are not intrinsic to the environmental management system or company strategy/culture, which can nonetheless contribute towards more systemic green initiatives when repeated over an extended period of time.	
D2	Systematic	Activities that are not sporadic, but rather undertaken systematically according to a long-term plan and/or within a formalised environmental management system.	
E1	Technical and technological	Activities that are related to the technical aspects of a system and require specific technological means in order to be carried out.	

**Table 1.** Classification of identified green initiatives and practices

Initiatives and practices for greening logistics services on the polish market - status quo and... Magdalena Klopott, Joanna Miklińska

CODE	CATEGORY	DESCRIPTION	
E2	Organizational	Activities which entail organisational and managerial changes, in the context of either the internal functioning of an enterprise, or its relationship with partners or contractors.	
E3	Human-driven	Solutions which require hiring specialised staff, internal/external training, or raising the qualification level among staff members.	
E4	Economic	Pro-ecological investments financed by a particular company in order to balance out the negative effects of operational activities, e.g., carbon offsetting.	
F1	With direct outcomes	Activities resulting in direct, measurable and quantifiable outcomes, e.g., reduced fuel consumption.	
F2	With indirect outcomes	Activities resulting in outcomes that are of a more qualitative nature, which are difficult to measure and which can manifest themselves only in a longer timeframe, e.g., increased customer preference thanks to an LSP's efforts to provide $CO_2$ neutral transport.	
G1	SC-focused	Activities that span across the logistic chain and affect other supply chain actors.	
G2	Company- focused	Activities that are focused only on the single company involved in the SC. The impact of its green initiatives is largely limited to the boundaries of the company.	

Source: own elaboration

The content analysis revealed that as many as 37% of the surveyed TFL companies do not provide information on their environmental performance; this is the more surprising that we refer to the biggest companies operating on Polish TFL market. Such information is rather sweeping and only a few companies have extensive and rich content on their websites devoted to green and sustainable issues. As far as the questionnaire results are concerned, 18.75% of respondents admitted that they are not involved in green issues at all and they did not point out any green practice. Table 2 presents a summary of the identified green initiatives/practices along with the corresponding percentages of surveyed TFL companies that indicated their support for the particular ones.

INITIATIVE/PRACTICE	CONTENT ANALYSIS	QUESTIONNAIRE SURVEY
ISO 14001 environmental certificate	25.8%	35.7%
Other environmental certificates	3.22%	-
Vehicles/handling equipment technology	16.1%	6.25%
Alternative fuels	3.22%	6.25%
Energy management	9.6%	25%
Water management	4.8%	31.25 %
Environmental reporting	4.8%	-
Counting the carbon footprint	8%	-
Increasing environmental awareness	9.6%	-
Eco-driving	12.9%	6.25%
Intermodal transport	44%	18.75%
Optimization of route planning	11.3%	6.25%
Paperless office	8%	6.25%
Selective collection of waste	12.9 %	56.25%
Packaging	3.22%	-
Selection of subcontractors	4.8%	33%

**Table 2.** Percentage of surveyed companies that have indicated their involvement in a particular green initiative/practice

Source: own elaboration

The elaboration of initiatives and practices starts with **environmental certification** (A2, C1/C2, D2, F2), as this practice was mentioned most frequently regardless of the research method used. The aim of fulfilling strong ISO certification requirements is to demonstrate a company's commitment to environmental protection and it is considered to have a positive influence on its public image. These motives are also mentioned as the most important in implementing ISO standards, in Swedish studies as well (Poksinska et al., 2003, pg. 560). However, it is worth noting that ISO 14001 per se does not proclaim that the company is environmentally-friendly.

From the interviewed companies, two possess ISO 14001 certification and admit that accreditation has no practical effect on their overall environmental performance. This opinion coincides with the results of some research studies (Freimann & Walther 2001). The most visible effect is an improvement in the communication process between those responsible for environmental issues within a company. The remaining companies are not willing to apply for ISO 14001 or EMAS certificates as they perceive the process as too onerous, costly and without any real influence on environmental performance. However, other research has shown that organizations adopting EMS (formally or not) more frequently implement green supply chain practices, regardless of how long the EMS has been in place (Darnall et al., 2008, pg. 39).

As far as other green certificates are concerned, according to the information provided by the Polish Green Building Council, four certification schemes relating to diverse building and infrastructure types are being used in Poland, namely LEED, BREEAM, DGNB and HQE (PLGBC, 2017, pg. 1). These types of certificates are not so widely used or recognized in the TFL sector as the ISO standards. According to the results of content analysis, only a few LSPs exploit green, certified warehouses; however, there are 25 green warehouses in Poland, out of which 18 are BREEAM, and 7 LEED certified (Colliers International, 2016, pg. 4).

There are various practices followed by TFL companies in the area of transport technology, especially with regard to vehicles as well as cargo handling equipment, for example, forklift trucks or cranes (A2; B1/B2; C1; D1/D2; E1; F1; G2). Companies invest in fleet renewal and gradually replace old trucks (Euro 3 emission standards) with those that meet EURO 5 and EURO 6 emission standards. Reducing the EURO 3 vehicles initiative also has its economic impact as the company pays the lower charges in MAUT and Via Toll system and consequently the prices for carriage can be more competitive. The other common measure is investing in tyres technology and some companies use only energy saver tyres, which, provided the proper maintenance, can run over 100,000 kilometres on their original tread. These tyres have less rolling resistance which translates directly to lower fuel consumption. Moreover, the technology of producing these tyres allows repeated regeneration and recycling. (CLECEAT n.d., pg. 8) Another measure that is gaining popularity is alternative fuel (A1/A2; B2; C1; D2; E1; F1). Companies invest in LNG-fuelled vehicles, hybridelectric or electric vehicles and handling equipment, e.g., in warehouses or storage vards.

**Energy management** (A2; B1/B2; C1/C2; D2; E1; F1; G2) is another area where LSPs demonstrate their commitment to reducing emissions from their activity. The term "energy management" refers to a set of activities conducted within a company, which have a continuous character and aims at achieving the most efficient usage of energy in processes vital to its performance. Energy efficiency can be achieved, among others, through: monitoring of energy consumption, energy planning, selection of a relevant mix of supply sources or implementation of technical solutions enhancing energy efficiency.

Some surveyed companies inform publicly about their activities with regard to optimisation of energy consumption of offices and warehouses as well as handling equipment (e.g., electric forklifts). The common practice is the use of energy-saving lighting and lighting control systems for the interior hallways and rooms or installation of motion-sensing lighting in common areas. Changing energy-related behaviour of the staff also has a strong influence on energy consumption. Only one LSP informed about investments in alternative energy sources and had installed a photovoltaic plant within its vicinity which generates electricity used solely on the LSP's premises. All these activities in the area of energy management can amount to a significant reduction in companies' energy bills, so this is a win-win situation.

The most advanced approach to energy management is **carbon offsetting** (A2; C1; D2; E4; F2; G2). Even in the most advanced scheme of energy management the emissions cannot be completely eliminated. LSPs willing to achieve the "zero

footprint" should consider carbon offsetting. Applying such a sophisticated measure into a business strategy was only declared by one LSP.

In a similar fashion to energy management, we can refer to the practice of **reducing water consumption** (A2; B1/B2; C1/C2; D2; E1; F2; G2) which was also mentioned by respondents quite often. Companies pointed out measures used in order to achieve this goal, which include using tap aerators that may reduce about 50-60% of annual water usage as well as associated costs, installing motion sensors that activate flushing of the toilets or a vacuum system for flushing the toilets. A more advanced solution in the water management area is a water recovery system. i.e., collecting precipitation water from rain and snow and its subsequent usage in, for example, truck washers.

**Environmental reporting** (A1/A2; B1/B2; C2; D2; E2; F2; G2) is a practice that may be required by some countries or institutions. It is very often perceived as a bureaucratic burden, however may help in identifying sources/places where energy or other resources are wasted. Practice revealed that the monitoring and reporting may reduce the level of emissions even if other reduction measures have not been taken (for e.g., MRV regulation in maritime transport). Several companies decided to publish their environmental reports voluntarily in order to inform their customers and the public about their good eco-performance. It is suggested that the best idea is to introduce elements of environmental reporting on a voluntary basis and make it a promotional feature of the service (CLECEAT, n.d., pg. 9).

Since environmental issues, especially emission of GHG may be important to certain customers, LSPs enable the **counting the carbon footprint** (A1; B2; C1; D2; E1; F2; G1/G2) by means of dedicated CO<sub>2</sub> calculators which are available on their websites. In the basic version these calculators enable counting the CO<sub>2</sub> emission of a particular shipping route, but some are designed to calculate customers' carbon footprint for their whole supply chain including warehousing and distribution and allow identifying carbon reduction potentials in supply chains.

Human factors have a significant impact on environmental performance of the organisation. Some of the surveyed TFL companies take actions in the area of reducing the negative impact of transport and logistics on the environment by organizing seminars and trainings for their personnel, which aim at **increasing their environmental awareness** (A2; B1/B2; C1/C2; D1/D2; E3; F1/F2). The modification of behaviour patterns of personnel or subcontractors that affect the consumption of the resources may enhance not only the environmental, but also the economic performance of the company. Colicchia et al. (2013, pg. 208) in their study also revealed that environmental training programmes for personnel at all levels is of critical importance in achieving companies' sustainability targets.

Within surveyed transport and logistics companies, the most well-known programme of modification of human behaviour are trainings for developing driving techniques - **eco-driving** (A2; B2; C1; D1/D2; E3; F1/F2; G1/G2). The company can also monitor and analyse driving eco-parameters of particular drivers as well as follow the trends in relation to the whole fleet. Eco-driving generates savings of fuel and associated costs and may also lead to lowering insurance premiums.

Green logistics and transport require **intermodal transport** (A2; B2; E1/E2; F2; G2). It is common knowledge that a modal shift from road to rail, inland waterways

transport or short sea shipping results in better SC performance in terms of GHG emissions. A small number of respondents admit that they attempt to convince their customers to organize transport using more environmentally-friendly modes of transport and carry their cargoes by intermodal transport. Understanding the interactions between intermodal transport activities and their impact on the environment is a key issue in promoting this eco-friendly transport system. Among the biggest LSPs operating on the Polish market (listed in the above mentioned ranking of Brdulak, 2016, pgs. E4-E5) about 44% perform their services utilizing intermodal transport. Considering the Polish TFL market, this means that rail transport prevails over other environmentally-friendly modes and inland waterway transport has no practical significance.

Another measure to improve the environmental as well as economic performance is **optimization of route planning and fleet utilization** (A2; B2; C1; E1/E2; F1/F2; G1/G2). In order to be profitable and eco-friendly, there should be no imbalance between outbound and inbound freights. Some of the TFL companies, in order to utilize the loading capacity effectively, use dedicated route planning and optimization software. IT-optimized fleet management systems are gaining popularity among LSPs as they improve utilisation of transport fleets and reflect in the reduction of costs.

The remaining green practices undertaken by LSPs include commonly known measures such as a document management system which gives the possibility to manage a **paperless office** (A2; B1/B2; D2; E2/E3; F1/F2; G2) or **selective collection of waste** (A1/A2; B1/B2; C2; D2; E2; F1) in the offices as well as in warehouses and other premises, sometimes in close cooperation with recycling companies. Additionally, the practice of **reusable and collective packaging** (A2; B2; C1; D2; E1/E2; F1; G1) is employed by LSPs as there are still possibilities of improvement in this area leading to economic and environmental benefits.

The last but not least practice of companies is the careful **selection of contractors** (A2; B2; E2; G1). As many as  $\frac{1}{3}$  of respondents do not consider the green criterion at all when choosing subcontractors, unless it is expressly required by a customer. The companies which do so (e.g., one of interviewed companies) cooperate only with other companies (contractors) which care about the environment in the same way (e.g., fleet service company has a close circuit of waste oil, which is disposed to respective stations) or enforce its high green standards on subcontractors willing to cooperate with them (e.g., subcontractors must only operate trucks that meet the emission standards EURO 5 or 6).

# 5. FACTORS BEHIND THE (NON-)IMPLEMENTATION OF GREEN SOLUTIONS BY LSP ACTING IN POLAND

There are different reasons underlying the implementation of green initiatives and practices as well as being reluctant to them among the LSPs operating in Poland.

The analysis of common practices revealed that especially favoured are those allowing the company to demonstrate its involvement in environmental protection and that are considered to have a positive influence on the public image (for e.g., ISO 14001). However the majority of LSPs' green practices have a direct influence on their economic performance and this is the primary reason underlying their adoption, as there is a little environmental awareness without an economic interest.

The issue of obstacles behind the implementation of green solutions by LSPs is very complex. They may have different sources (e.g., may derive from customers, LSP as such or subcontractors) as well as diverse nature (e.g., arise from financial constraints, lack of environmental awareness or lack of necessary knowledge).

The results of the survey indicate that a lack of, or insufficient interest in, green services is the main barrier to the adoption of green solutions, as only 33.3% of customers express their requirements for green TFL services. The cost of the TFL service, time of delivery as well as quality of the service still constitute the most important criteria for customers. (Klopott & Miklińska, 2016, pg. 5).

Likewise, LSPs pointed to a lack of environmental awareness among their customers as the main barrier of developing green services. The general rule is that these are international companies with a stable market position, which are eco-aware and interested in green solutions.

The factors that hinder the development of green TFL services may also be attributable to LSPs' attitude and abilities. As many as 46.7% of LSPs admitted that the main hindrance is their lack of readiness (organisational, technical as well as financial) to fulfil the green requirement of their customers (Klopott & Miklińska, 2016, pg. 4). This negative attitude exceeds the simple relation LSP-customer and transfers into relations with subcontractors, as – what has been mentioned earlier – 33.3% of respondents do not consider the green criterion while choosing them.

Conducted interviews disclosed financial issues as an important reason behind such a domino effect; however, it is not a single problem. While green solutions are not obligatory, the lack of environmental awareness as well as relevant knowledge of possible solutions are strong impediments in the development of green practices in the market. We also noticed that many green activities are of an ad hoc or random nature are not an element of a company's green policy or strategy. It also happens that some companies adopt a particular green solution without being aware of their environmental importance and consequences, which is also an undesirable effect.

Financial matters, however, are not only a barrier, but in particular circumstances may appear as a factor encouraging the environmental-friendly activities. As research results indicated, it is particularly visible in the non-operational activity of the company (B1). Interviewed companies pointed to an unstable economic climate among other barriers underlying the involvement (or lack thereof) in green practices, as well as a lack of economic incentives encouraging to undertake green investments.

#### 6. CONCLUSION

Based on the research findings we can conclude that the greening of the Polish TFL market is still at an early stage of its development. Identified and analysed diverse green initiatives and practices allowed us to distinguish their two main categories.

The first category includes practices which are sort of a challenge for LSPs as their implementation needs considerable financial investments in assets or utilizing sophisticated technical or technological solutions or require significant organizational changes. These practices usually relate to the operational activity of a company and often result from precise requirements of LSPs' customers, usually those with a stable economic position.

The initiatives and practices that belonged to the second group are connected with the non-operational activity, do not require substantial financial investments but rather an appropriate "green" attitude and willingness to change behaviour for the sake of the environment. These types of initiatives usually bring cost savings visible in the short-term.

We note with regret that there a lot of companies on the Polish TFL market that overlook the problem of the TFL sector's negative influence on the environment and the issue of green solutions is neglected by them. We may conjecture that the reason for it lies in the financial capability and focusing mainly on everyday business in order to survive on the competitive and turbulent TFL market. However, a question arises, how long will these companies be able to compete on the contemporary global market having such a strategy and attitude to "green matters"? It seems that it will be difficult to avoid green requirements in the future (we can rather expect a rising demand for green solutions). We can claim that it is the "green attitude" translating into practice and supported by IT solutions that may become a factor of great influence on a company's competitive position in the near future.

There are a lot of determinants fostering further development of the Polish TFL market (improvements in the area of transport infrastructure in Poland as well as expansion of e-commerce, among others) and a subsequent increase in demand for TFL services as well as development of modern warehouse spaces. Alongside the projected development of this market, the scarcity of green practices may evolve into a serious problem soon. The one factor we should not omit in our deliberation is the rising environmental awareness among society and it will be the individual clients choosing the goods with a lower carbon footprint who will become a driver of the greening of the supply chains.

Identified and discussed barriers in implementation of green solutions (e.g., lack of awareness or willingness) must be overcome. Nowadays, the choice of "green" measures seems to be the only path to pursue.

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# EXPLORATORY RESEARCH OF FOOD WASTE GENERATION AND FOOD WASTE PREVENTION IN THE HOSPITALITY INDUSTRY – THE CASE OF ZAGREB RESTAURANTS

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#### Abstract

Food supply chains and their coordination (delivering requested amounts of food on time, to the right location, with minimum food waste) are becoming more complex nowadays and they present a growing challenge for all food supply chain participants, from producers and retailers in service industries to end consumers. It is beyond doubt that food waste has become a global issue of our time as a result of mass food production. Researches have shown that most food is wasted at the end of the supply chain, i.e. in the hospitality industry and in households. It is precisely for this reason that this paper aims at a more detailed research of food waste in catering facilities, i.e. in restaurants. For the purpose of this paper, exploratory research was conducted on a sample of 20 restaurants in Zagreb via an anonymous questionnaire which analysed food waste and the possibilities of its prevention. Results indicate that restaurants are familiar with food waste issues and that most food is wasted in the process of food preparation (before serving). Restaurants are getting more and more concerned regarding waste, but recycling or food donating is still not a part of standard restaurant business practice. In conclusion, there is a necessity of raising employee and guest awareness of the growing food waste quantities, as well as of proper methods of food waste management that can prevent it.

**Key words:** food supply chain, food waste, hospitality industry, restaurants, food waste prevention methods, Zagreb

#### 1. INTRODUCTION

Today, when almost 800 million people in the world are starving, food waste has certainly become a global issue as a consequence of mass food production. According to the data from the Food and Agriculture Organization of the United Nations (FAO), Exploratory research of food waste generation and food waste prevention in the hospitality industry... Ana-Maria Cuglin, Kristina Petljak, Dora Naletina

1.3 billion tons of food is globally wasted every year. In developed countries, over 40% of food is wasted in retail and consumption phases, while in developing countries, the percentage pertains to the loss of food during harvest and processing (FAO, 2016). In Croatia, more than 400,000 tons of food gets wasted annually, i.e. 90 kg per capita (The Croatian Environment Agency, 2014). The consequences of food waste are significant because they affect the environment and climate change.

The existing researches show that most food is wasted by consumers at the end of the supply chain, i.e. in the hospitality industry and in households. Besides the available handbooks for consumers and hospitality facilities, no research on food waste in restaurants has been conducted in Croatia. This is the reason why this paper carried out a research of Zagreb restaurants, with the aim of providing answers to the following questions: 1) Do these restaurants take care of the food waste?; 2) What happens to the food that is no longer suitable for use in restaurants?; 3) Are there activities which help prevent food waste in restaurants?; and 4) In what way is the food waste dealt with in Zagreb restaurants? The paper will also analyse the methods and activities which can significantly help prevent food waste during the supply, storage, preparation and serving stages.

## 2. FOOD WASTE IN THE SUPPLY CHAIN

#### 2.1. Terminology

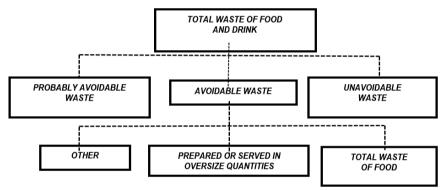
According to FAO (2016), there is a difference in the definition of food loss and food waste in the UN "Save Food" Initiative. Food loss refers to the decrease in food mass or in its quality, which makes it unsuitable for human consumption (FAO, 2011). Food losses are present in the production process and during the distribution in the food supply chain. On the other hand, food waste (which is a component of food loss) implies any kind of food being removed from the supply chain. This food has been or was suitable for human consumption at some point, or its shelf-life has expired, which most often is caused by poor food management or by the negligence of employees. According to Buzby *et al.* (2014), food loss is defined as the amount of edible food available for human consumption, which has for some reason not been consummated, while food waste refers to edible food not consumed because of certain human factors and actions.

Costello et al. (2016) define two types of food waste:

- food waste before its consumption it involves kitchen leftovers (any organic material that is thrown away during food preparation, like peels, grease, fruit and vegetable parts; it is considered inedible) and food which has rotten (either the shelf-life has expired or it is decomposing; it is considered inedible), and
- food waste after consumption it includes the food served to the guests that has not been eaten.

The European and Croatian healthcare define bio waste as biologically degradable waste from parks and gardens, food and kitchen waste from households, restaurants, hospitality facilities and retail stores, including similar waste in food product processing (Voća, 2014). The term bio waste is often confused with biodegradable waste which, along with bio waste, includes other types of biodegradable waste, such as the waste from the forestry sector, fertilizer waste, paper, cardboard, textile etc. When considering the possibility of its mitigation, food waste can be classified into several basic categories: <sup>3</sup>/<sub>4</sub> the waste which can be avoided (avoidable waste), like food that was edible before being thrown away (like bread, apple, meat); <sup>3</sup>/<sub>4</sub> of the waste that has a large potential of being mitigated (likely avoidable waste), such as food being consumed by some people and not by the others (like bread crumbs) or, food which can be edible based on its preparation (like potato peel); <sup>3</sup>/<sub>4</sub> the waste which could not be avoided (unavoidable waste), like the waste produced during food preparation which is not and never has been edible (like bones, egg shells, tea bags), as shown in Figure 1.

**Figure 1.** Classification of food and drink waste relating to the possibility of mitigating their production



Source: Voća (2014:8)

The waste that can be avoided refers to the food that has been prepared or served in excessive amounts, food that has been damaged during the preparation (burnt food, for example) and food products that have not been consumed i.e. their shelf-life has expired. In providing hospitality services, most waste is not hazardous and, if it cannot be reused in the very facility, it is important to separate and store it and hand it to the authorized waste management company. Almost all types of not hazardous waste produced by the hospitality industry can be processed, i.e. can be used for making raw materials or new products. For example, food waste can be used for anaerobic digestion, composting, production material or energy production; waste packaging can be used as materials or for recycling materials and the production of new ones; wood and paper waste can also be reused for material and energy recycling (Voća, 2014).

## 2.2. Sources of food waste in the supply chain

According to FAO, one third of total food mass produced for human consumption is wasted. At the same time, global food production uses 25% of

inhabitable land, spends 70% of drinking water supply, causes 30% of greenhouse gas emission and 80% of deforestation (FAO, 2016). Food production is one of the leading factors of change in the use of land and in the loss of biodiversity, and food waste poses a missed chance for improvement in the field of global food supply, as well as in the mitigation of negative influence on the environment, human health and natural resource exploitation.

The awareness of food waste as being problematic and irrational has been rising in Europe and in the world, especially because it is not just the environment that is in question, but socio-economic and moral issues as well. Many countries have diligently begun collecting data and information on this type of waste to reduce food waste. They are also trying to define waste production management and are making efforts to educate and inform the public.

When observing the food waste issue as a whole, it is necessary to focus on the waste prevention concept and the evaluation of its impact on the environment through the product life cycle analysis (LCA). The life cycle analysis includes the primary (agricultural) production, handling and storage after the harvest, processing, distribution, consumption and the end of the life cycle i.e. becoming waste. Food waste quantity could be also affected by problem of pure motivational compensation of employees on closest supply chain level to final consumer (Turkalj et al., 2010), who are not adequately motivated for proper handling and exploitation of food products.

The causes of food loss in the supply chain are various (Parfitt *et al.*, 2010): for example, losses due to improper storage of raw materials or products, wasting of food during its handling or transportation, waste production in the distribution phase because of the expired shelf-life, etc. More effective implementation of measures for mitigating food waste in the first stage of the supply chain means reducing negative influence on the environment and less food losses. During transportation, preparation, distribution and consumption there are additional risks of food waste, which also implies the accumulation of negative influences on the environment and food loss risks. Food supply chain consists of five phases and there is a risk of food wastage in all of them (Figure 2.).

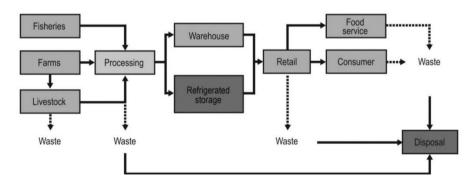


Figure 2. Critical points of food waste in the supply chain

In the long chain, between production and consumption, there are multiple stages at which some form of loss, spillage, waste or loss of food might take place, be it in the production, storage, distribution or during actual consumption (Jagau and Vyrastekova, 2016). However, the food waste occurs mainly in the final stages of the supply chain – during the food distribution and consumption phases.

#### 2.3. Secondary data on food waste

Today, when almost 800 million people in the world are starving, food waste has certainly become a global issue mass food production has created. Despite that, according to the data from FAO, 1.3 billion tons of food is globally wasted every year – double than what is needed to feed all the hungry people in the world (Royte, 2016). Where does all this food go? Only in Croatia, more than 400,000 tons of food is wasted, which is 90 kg per capita (The Croatian Environment Agency, 2014), while the number for the entire world goes up to one third of the produced food. In developing countries, plenty of food is wasted after the harvest due to inconvenient storage, poor road conditions and cooling systems (Gustavson *et al.*, 2011). In comparison, developed countries waste more food further down the supply chain - traders order, serve or display too much food, while consumers ignore the leftovers in the back of the refrigerators or throw away perishable foods before the expiration date. The remarkable fact is that almost one third of edible parts of food produced for human consumption is being wasted, which is around 1.3 billion tons a year (Royte, 2016).

Food is wasted throughout the supply chain (Bloom, 2011), from the initial agricultural production, to the final household consumption. In developed countries, food is being wasted in huge amounts, which means that it is thrown away even if still edible and good for preparation and consumption. In underdeveloped countries, food is mostly wasted in the early and middle stages of the supply chain; least is wasted in the consumption phase (Gustavson et al., 2011). Food loss per capita in Europe and North America is 280-300 kilograms per year. In sub-Saharan Africa and in South/Southeast Asia the loss is 120-170 kg per year. The entire production of edible food for human needs per capita is around 900 kg in Europe and North America, while in sub-Saharan Africa and South/Southeast Asia it adds up to 450 kg a year. European and North American consumers waste about 95-115 kg of food every year, while the data for sub-Saharan Africa and South/Southeast Asia shows that they waste only about 6-11 kg per year. Food waste in industrialized countries is as high as in developing countries, but the latter produce more than 40% food waste after the harvest and during the production processes, while industrialized countries create 40% food waste at the end of the supply chain, i.e. in retail (Gruber et al., 2016) and during the consumption phase. Food waste by consumers in developed countries (222 million tons) almost equals the total net food production in sub-Saharan Africa (230 million tons).

Food waste also takes its toll on the environment (Royte, 2016). Food that is produced and left uneaten – be it meat or cakes – means wasting water, fertilizers, pesticides, seed, fuels and land necessary for its growth. The amounts are not insignificant. The annual production of uneaten food "drinks up" as much water as

the annual water flow in the Volga, the water-richest European river (Tristram, 2009). These stunning figures do not even include losses on the farms, watercrafts and slaughter houses. If food waste was seen as a country, it would be the third largest greenhouse gas emitter in the world, right behind China and the USA.

On the planet with limited resources and anticipated population growth of at least two billion by the year 2050, many activists have been putting forward their arguments for reducing food waste, which has now become an international issue (Maddyck, 2015). The French Senate, for example, has unanimously adopted the law proposed by the local councillor Arasha Derambarsha, which dictates that all supermarkets are obliged to donate foods that cannot be sold due to their appearance or their short shelflife to public community kitchens and charities. The fines for not obeying the law are up to 75 thousand euros.

In September 2015, the UN committed to cut food waste in half by the year 2030. In December, the European Union issued a proposal for a directive according to which all Member states have to take measures for food waste mitigation in accordance with the goals of 2030 Agenda for Sustainable Development (reducing retail and consumer food waste per capita by at least half the current state and reducing food waste in production and supply chains). Specific mechanisms of this ambitious plan have not been defined. Nevertheless, some countries and companies have already been designing and adopting standards for determining quantities of food waste. In October 2015, Croatia adopted the Regulation on the conditions, criteria and ways of donating food and feed. Although with many defects, the Regulation has led to donation exemption from the VAT system in December (Sokolić, 2015). If the goal of the UN is achieved, enough food will be saved to feed at least one billion people.

## **3. PREVIOUS RESEARCH**

Over the last few years, the issue of food waste has imposed itself as an extremely important and taunting research area (Principato et al., 2015; Blondin et al., 2014; Charlebois et al., 2015). The existing researches point out that food is being wasted in huge amounts and that solutions must be found and individuals warned about food waste consequences. Up until now, researches have been focusing on the specific phases of the supply chain, such as food waste in retail (Gruber et al., 2016), or household food wasting (Silvennoinen et al., 2014; Lanfranchi et al., 2016). The research focus has been directed towards consumers (Principato et al., 2015; Setti et al., 2016; Grandhi and Singh, 2016), while the hospitality industry has been neglected or extremely rarely researched (Christ & Buritt, 2017). In the existing empirical research, case studies dominate, although the interest in food waste in hospitality industry is increasing. Researches on food waste in Croatia are rare (Kalambura et al., 2014; Knežević et al., 2017), especially in the hospitality industry. Therefore, to elaborate on this current and complex theme, for the purpose of this research and during research instrument design, the guidelines of the previous researches have been followed with the focus on the hospitality industry, specifically the food waste in the hospitality industry (Principato et al., 2015; Charlebois et al., 2015).

The research conducted by Principato et al. (2015) in Italy focuses on household food waste, which includes food grown at home, food bought at stores and food waste from the restaurants. The research was conducted due to the fact that younger population wastes more food than adults, which has also been shown by the researches conducted in Great Britain (Osner, 1982; Lyndhurst, 2007). The research was conducted on a sample of 233 students and the results have shown that 84% of the participants are familiar with the economic and environmental issues concerning food waste. The most popular communication channel through which they receive information on food waste is television (78.6%). About <sup>3</sup>/<sub>4</sub> of the examinees stated that they had reduced the quantity of wasted food, while 68.5% said they regularly went shopping for groceries with a shopping list.

The research by Blondin et al. (2014), conducted in America, was initiated by the concern of school employees (principals, teachers, cooks) on increasing food wastage. The research was conducted in ten schools and it pointed out three factors that explain food waste: the first factor is connected to the food itself, the second to the children and the third to the programmes. Regarding the first factor, food waste can be the result of the expired shelf-life, even if it is just one day overdue, or the food does not appeal to children and is left untouched and therefore thrown away due to regulations, or the food that should be served hot or warm gets cold because children did not arrive on time and is also thrown away. As for the second factor, children decide for themselves how much they will eat - sometimes they eat everything, sometimes nothing, because they are either not hungry or they do not like what is on the menu. The third factor relates to food waste due to short breaks. According to the research, food products that are thrown away the most are milk and fruits.

One of the most significant researches on food waste is a research conducted in Canada in the famous Delish restaurant chain (Charlebois et al., 2015). According to this research, there are several reasons for food waste. Food industry needs suppliers and different inputs on all levels in order to create dishes for their guests. Also, another important determinant is the management which plans and manages the budget and risk reduction. There are strict regulations on the conditions in which food should be preserved. It is up to the management to decide which methods to adopt regarding food safety requirements in restaurant kitchens, including the supplies and storage control. Furthermore, it is necessary to anticipate costs before they arise. Cost prevention factors include good employees, effective training and equipment maintenance. Making a mistake in any of these variables may lead to guest complaints and sales reductions. The research also focuses on kitchen management and organization. The key emphasis is put on kitchen hygiene because many employees do not regard it as important and constant training is needed in order to make it an everyday practice in restaurant kitchens. Communication and trust between the management and the employees is also crucial in order to achieve the goals of the organization. If the conditions at work are good, employees will perform better. The last determinant is the supply and demand management. Food demand can be influenced by the weather and local events, and these unexpected fluctuations can influence the already prepared food by going bad before being eaten. That is why it is very difficult to plan and order goods ahead. Food waste occurs because of overprocessed food, inadequate preserving temperatures, the equipment not functioning properly or inappropriate menus. According to the research results, relations with the suppliers do not have much influence on food waste prevention. The communication between the management and the employees is often not at its best and it mostly comes down to the communication between the manager and the chef who is responsible for everything. The employees are not involved in the food waste prevention programme and are only included when they feel the wasted food is their fault. There is no recycling and the food is directly thrown away. New employees are blamed if something goes wrong, for example when the waiter is not familiar with the menu or if portions are larger than usual and guests return the food which is then thrown away.

# 4. EMPIRICAL RESEARCH ON FOOD WASTE IN HOSPITALITY INDUSTRY – THE CASE OF RESTAURANTS IN ZAGREB

## 4.1. Research methodology and sample

In order to research food waste in the hospitality industry in more detail, an exploratory research was conducted via face to face method with the research instrument in a form of a questionnaire consisting of 28 questions. The research was conducted on a sample of 20 respondents working in hospitality facilities in Zagreb (Table 1.). Most facilities are restaurants (75.00%), then bistros (10.00%) and pizzerias (10.00%), and fast food restaurants (5.00%). According to the respondents' assessments, more than 4.000.00 kuna are spent on the daily purchase of food in the surveyed restaurants.

variable	category	n
gender	male	18
	female	2
age of respondents	15 – 24 year	1
	25 – 34 year	8
	35 – 44 year	5
	45 – 54 year	1
	55 – 64 year	5
	older than 65 years	0
working place	owner of the restaurant	10
	restaurant manager	6
	chef	4

Table 1. Socio-demographic characteristics of the respondents

Source: empirical research

Participants in the research were mainly male (90.00%). Most respondents were between the age of 25 and 34 (40.00%) and between the age of 55 and 64 (25.00%). The average working life of the younger participants was between 5 and 10 years, while the average working life of the older respondents was between 20 and 30 years. The respondents were asked to state their position in the restaurant. Restaurant owners participated in the research for the most part (50.00%), followed by restaurant

managers (30.00%) and chefs (20.00%). When analysing the number of employees, the data varies. Most restaurants have 10 to 20 employees, while two of them have 72 and 28 employees respectively. Out of the total number of restaurants participating in the research, only four have fewer employees than the average (two smaller restaurants, a bistro and a fast food restaurant).

# 4.2. Research results

Out of the 20 restaurants the research was conducted on, 6 restaurants purchase fresh groceries twice a week, while 14 of them make the purchase more than 3 times a week i.e. almost every day. All restaurants state that they easily store perishable foods like milk, eggs, fish, meat or seashells in the refrigerators. Most of the restaurants do not have a vegetable or herb garden at the facility, while few state that they grow culinary herbs like basil, thyme, oregano, rosemary or chilli peppers in containers.

When analysing food waste in these restaurants, one part accounts for the waste which occurs in the kitchen, i.e. it occurs before the food reaches the guest. The other part is the food that is thrown away after the guests leave, i.e. leftover food from the plates. In the research, 9 restaurants stated that almost 20% of the purchased food is thrown away before being served, 7 restaurants waste 10%, while 4 restaurants waste between 30 and 40% of the purchased food. Evidently, it is a high percentage of food being wasted in the preparation phase, before it arrives on the table.

The respondents were further asked to assess the percentage of prepared food (entrée, main course, dessert, menu) which is thrown after the guests leave. Most restaurants (n=14) said they throw away 10 to 20% of food after the guests leave, 4 restaurants throw away 20 to 40% and two respondents could not give the approximate data. The research has revealed that in most restaurants guests almost never choose to take their leftovers home (*doggy bag*). Restaurants have noticed there are certain groceries that are most often left by the guests. Those are, in order of frequency, bread, vegetables, fats (e.g. from meats), salad and fries (*Figure 3.*).

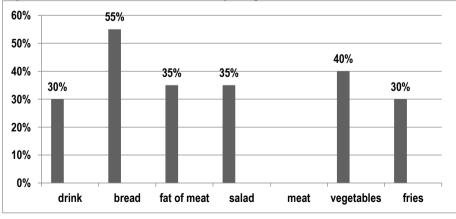
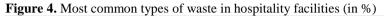


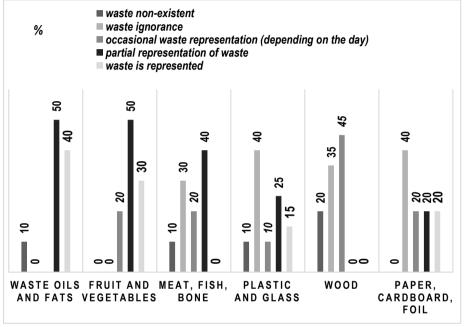
Figure 3. Food which is most often left by the guests in the researched restaurants

Exploratory research of food waste generation and food waste prevention in the hospitality industry... Ana-Maria Cuglin, Kristina Petljak, Dora Naletina

Source: empirical research

Every hospitality facility creates waste during food preparation and strives to find the best way for its disposal. The respondents were therefore asked to state the quantity of certain type of waste in their facility (waste oils and fats; fruits and vegetables; meat, fish and bones; plastic and glass, wood and paper, cardboard and foil). Figure 4. shows the most common types of waste in hospitality facilities.





Source: empirical research

The most common types of waste in restaurants are: (1) waste oils and fats, (2) fruits and vegetables, (3) paper, cardboard and foil, (4) plastic and glass, (5) meat, fish, bone and (6) wood. The first category, waste oils and fats, is partially present in all researched restaurants (almost 50%) and the same is with fruits and vegetables. The category of meat, fish and bones is partially present in 40% of the restaurants, while it does not exist in 30% of the restaurants. Plastic and glass category is not present in 40% of the restaurants, while in 10% of them it does not even exist because they recycle these materials. Other restaurants do not recycle them, so this type of waste is partially present. The next category includes wooden packaging for fruits and vegetables and is not present in 35% of the restaurants because the packaging is returned. In 45% of the restaurants, wood is sometimes present and sometimes it is not, depending on the day. The last category of paper, cardboard and foil is not present in 40% of the restaurants because they recycle these materials, while in other restaurants and sometimes it is present in 40% of the restaurants because they recycle these materials, while in other restaurants because they recycle these materials.

Further on, on a scale from 1 to 5 the respondents were asked to express the level of agreement or disagreement relating to the most common reasons of food waste in their restaurants (for example, *'because the shelf-life has expired', 'because we bought more food than was needed (we planned it poorly)', 'because food went mouldy', 'because food had strange odour and texture', 'because we needed more space in the refrigerator or other places we store food in', 'because portions were too big'.* The scale from 1 to 5 reads as follows: 1 = do not agree at all, 2 = do not agree, 3 = do not agree and do not disagree, 4 = agree, 5 = agree completely.

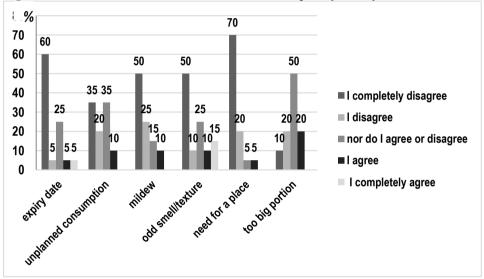


Figure 5. Most common reasons of food waste in a hospitality facility

There are a number of reasons why food is being wasted in restaurants. Some of them include expired shelf-life, ill-planned purchase, mouldy food or food that smells strange and has a strange texture, need for more storage space in refrigerators or simply too big portions (Figure 5.). Concerning food with the expired shelf-life, mouldy food or food that has strange smell or strange texture, 45-60% of the restaurants do not agree with the statement because the food with the expired shelflife is returned to the supplier (in line with their agreement). 30% of the restaurants do not agree at all with the statement "we throw food because we bought more than was needed", while 20% of them do not agree because without good purchase planning they could not survive on the market and would suffer losses. As much as 70% of the restaurants in question completely disagree with the statement that 'they throw away food because they need more space in refrigerators or other places they store food in', because when they notice that much more food is stored than usual, they buy additional refrigerators. 50% of the restaurants neither agree nor disagree with the statement that 'they throw away food because the portions are too big'. 20% of the respondents agree and 20% of them disagree with the same statement.

Source: The research

The restaurants estimate that they throw more than 20 kg of food (30% of the restaurants) on a weekly basis, 30% of the respondents estimate they throw 5 and 10 kg (smaller restaurants), and 30% of them state they waste between 10 and 20 kg of food. Kitchen leftovers and plate waste is thrown away in 85% of the restaurants, while the rest is recycled. Only one restaurant has a person in charge of food recycling.

The respondents were further asked to state what kind of food they buy in greater amounts and then have to throw away because they could not plan the expenditure. As many as 80% of them said there is a problem with the planning of fruit and vegetable expenditure since it can easily go rotten, especially if not stored properly.

When recycling is being analysed, the restaurants in question pointed out that they sometimes throw their food waste in specified garbage containers. Only one restaurant has recycling containers for bio waste, paper, glass and mixed municipal waste, while others plan to purchase them soon.

The respondents were further asked to scale their level of agreement or disagreement with the statements related to the food recycling obstacles (for example, *'insufficient number of recycling options', 'spatial limitations', 'transportation limitations', 'taking care of collecting and storing concerning food safety', 'unclear legislation'*). The scale from 1 to 5 reads as follows: 1 = do not agree at all, 2 = do not agree, 3 = do not agree and do not disagree, 4 = agree, 5 = agree completely.

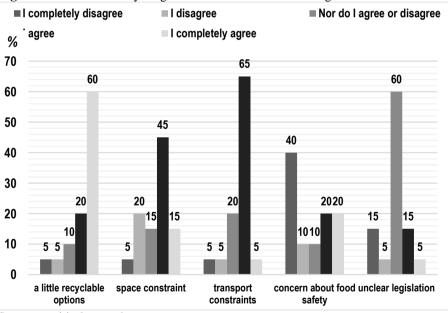


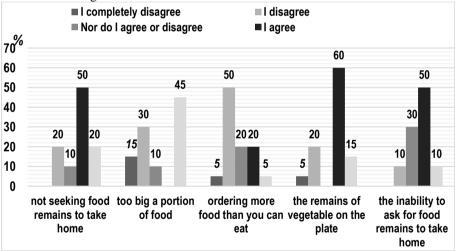
Figure 6. Food waste recycling obstacles in restaurants in Zagreb

As many as 20% of the respondents agree with the statement that 'there are limited recycling options'. The restaurants in question are situated in the centre of Zagreb, where there are no recycling options in suitable locations and it is therefore

Source: empirical research

easier to throw everything together in the same container. As many as 45% of the respondents agree that 'there is not enough space in the restaurant for storing waste'. 65% of them agree with the statement that 'transportation limitations are an obstacle to recycling'. Namely, the respondents agree that the waste is collected at inappropriate times, for example every other night, when the restaurants are busiest, instead of being collected in the morning. Likewise, restaurant owners do not have the appropriate vehicles to transport waste. Furthermore, as many as 40% of the restaurants completely disagree that 'taking care of collecting and storage concerning food safety' is an obstacle to recycling because food safety is a must. As many as 60% of them are indecisive about 'unclear legislation' being a food waste recycling obstacle.

When asked which communication channels they use to receive information on food waste, the respondents' answers included magazines, television and the word of mouth. Certain amount of food in the restaurants is being wasted by guests. Most often guests order more they can eat and then leave the plate waste instead of asking to take it home, and their leftovers have to be thrown away for health reasons. The respondents were asked to express their level of agreement or disagreement with the statements regarding food waste made by guests.



**Figure 7.** Respondents' perception of the reasons why guests create food waste in restaurants in Zagreb

Source: empirical research

Vegetables are wasted at higher rates than other food and are most often left on plates by guests. Furthermore, as many as 45% of researched restaurants agree with the statement that '*the guests complain about portions being too big*' and think they need to cut their size. Most of the restaurants in question think that guests feel uncomfortable asking for leftovers, and at the same time, most of them think that guests do not order more than they can eat. Only 30% of the respondents disagree with the statement that '*the portions are too big*'. In order to avoid unnecessary food waste,

it is crucial that the employees who are in contact with guests explain the size of the portion and what it consists of, if not already stated on the menu. It is also important to ask the guests if they want the leftovers to be packed to go, instead of waiting for them to ask first.

## 4.3. Discussion

According to the research results, it can be concluded that the employees in the restaurants in question are already familiar with the issue of food waste and its consequences, but restaurants still don't have a specific method for food waste prevention.

Most food in Zagreb restaurants is wasted in the phases before the food is being served, and it includes waste such as, for example, vegetable and fruit leftovers, bones, egg shells, or accidental spillage of food and drink, a dish gone wrong, etc. The food waste reduction at this stage leads to lower costs and has positive influence on the environment. The restaurants are careful with the daily or weekly grocery purchase planning and food is rarely stored in excessive amounts. If more is ordered than needed by mistake, or if the delivered food is rotten or not fresh, the food is returned and replaced due to the agreement obligations. Everyday menu planning is crucial for restaurants, as well as providing portions that should not be too big.

The restaurants should cut side dish portion sizes, since they are most often left on the plate and thrown away in the end (for example, fried potatoes, salads and sauces, etc.). It can be concluded that the researched restaurants are not exactly sure what amount of food is being wasted, because there is no kitchen management system or a person in charge of it. The communication between employees is crucial in restaurants, especially between chefs and waiters, so that the actual dish is prepared as ordered. Also, restaurant employees should be educated to take orders as precisely as possible and to communicate them with the kitchen staff more efficiently to prevent mistakes and avoid the food being returned by guests. Although there are numerous guidelines and handbooks, as well as hospitality facility legislation, the food waste issue is still understated and not a priority. For this reason, very few restaurants recycle and none of them has recycling containers at their facilities. It is necessary for the state to pass legislation to reduce food waste all restaurants should abide by and in that respect, mitigate unnecessary waste, or at least entice restaurants with certain incentives to take care of food waste and begin recycling it.

## 4.4. Limitations and recommendations for future research

The research on food waste in Zagreb restaurants was carried out on a sample of 20 restaurants, which is a relatively small sample compared to the total number of restaurants in Zagreb. The sample represents a certain limitation in forming general conclusions, and future researches should therefore include more restaurants in the Zagreb area and wider. A more structured analysis with performance indicators related to food waste would contribute to the internal validity of the study. The results of this research largely depend on the type of hospitality facility, its location and its offer, which are additional variables to be considered in the future. Furthermore, the

research collected the data from the restaurants' employees (mainly the owners), which can imply possible subjectivity and selectivity while answering the questions and covering the facts that could consequently undermine the reputation of their restaurant. Nevertheless, if the research included more respondents, the possibility of making more generalised conclusions would be greater. As far as the consumers, i.e. the guests of the restaurants are concerned; it is preferable to include them in the research as well.

## 5. CONCLUSION

Food is wasted in every stage of the supply chain, from the initial agricultural production, through retail and service to the final consumption in households. In developing countries, food is wasted in large amounts, even when still suitable for consumption. Certain amounts of food are wasted and thrown away in the early phases of the food supply chain. In underdeveloped countries food is mostly wasted in the production and processing phases due to poor storage conditions and transportation limitations.

With the aim of presenting possibilities for food waste prevention, an exploratory research has been carried out via a questionnaire on a sample of 20 hospitality facilities, mainly restaurants, all of which are already familiar with the food wasting issue. The analysis of the research results shows that the restaurants mostly waste food in the preparation phase (fruit and vegetable leftovers, egg shells, waste oils and fats, accidental spillage), while slightly less food is wasted after the consumption by the guests. Therefore, the food preparation phase can be seen as critical and needs to be analysed further with the aim of better food management in restaurants. Food that is most often left by the guests includes salads, fried potatoes, sauces and vegetables, and it is therefore necessary to offer smaller portions and charge prices accordingly (e.g. the children's menu) or serve smaller portions with the possibility for the guest to order more. Guests often think they can eat the entire portion so they order different side dishes and almost always overestimate their hunger. It is necessary to ensure good communication between guests and waiters, where the waiter, unless it is already indicated on the menu, will inform the guests on the content and the size of the portion.

The research has found that the restaurants do not have suitable recycling systems. Due to spatial limitations and insufficient recycling options, very few restaurants in question sort out food waste in appropriate recycling containers; paper and cardboard are mostly recycled because there are licensed companies in charge of this type of waste. The Sustainable Waste Management Act (NN 94/13) specifies that the produced waste should be separated on the spot in order not to get it mixed and to properly treat it in the future. It is crucial to raise awareness of restaurant owners and their guests about the fact that throwing food away leads to environmental contamination. Unconsummated food production leads to unnecessary CO<sub>2</sub> emission. In the world with limited resources (land, water, energy), where cost efficient solutions produce enough safe and nutritious food, food waste reduction should not be a priority easily forgotten. *As such, food waste reduction is likely to be receiving* 

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more attention over the coming decades as one of many environmental and health campaigns that seek to achieve positive social changes in society. It is timely for the foodservice sector to become more engaged in food waste reduction initiatives (Mirosa et al., 2016).

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# ECO-INNOVATIONS IN THE SPHERE OF MUNICIPAL WASTE MANAGEMENT IN A POLISH CONTEXT

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#### Abstract

Despite many of the actions taken by the European Union, the mass of municipal waste deposited in Member States' landfills is too large. One of the solutions to this problem is the use of eco-innovation in the management of municipal waste. Poland is a country which has made a lot of progress, and brought its landfill waste indicator down from 53% in 2014 to 44% in 2015. This paper allows us to answer the following questions: What is the attitude of Polish entities involved in waste management to eco-innovation and what are the environmental and financial implications of the ecological solutions used? Therefore, the main purpose of this article is to answer these questions based on the research conducted.

In order to illustrate the situation, this article begins with an overview of the literature and with a presentation of the condition and level of eco-innovations in Poland, as compared with other countries of the European Union. The presented data are based on secondary results. Later parts include examples of Polish eco-innovations in the sphere of handling municipal waste. Results of the survey and the results of the questionnaire are also presented, which indicate the direction of the necessary actions leading to increasing the number and efficiency of eco-innovation.

Key words: eco-innovation, municipal waste management, ecological innovation in Poland

## **1. INTRODUCTION**

Municipal waste management is a complex and multidisciplinary process which deals with managing waste from the moment it is generated until its time of neutralization. Its scope covers collecting, accepting, moving, transporting, disposal, as well as storing (Das & Bhattacharyya, 2015, pg. 9). A good and effective waste management system should take the relations and inter-links between the above elements into account, in consideration of their costs and negative effects on the environment (Singh, Gupta & Chaudhary, 2014, pg. 347). Moreover, it should allow implementing European Union policy, which imposes on its Member States the obligation to reduce the number of municipal waste produced, and to organize a procedure for collecting and managing the produced waste that is in accordance with the adopted hierarchy.

Numerous European Union countries still struggle with the problem of excessive amounts of municipal waste. According to Eurostat data, the average EU

figure for the year 2015 was 477 kg per single resident. The most waste, as much as 789 kg per capita, was produced by the citizens of Denmark; they are followed by the residents of Cyprus, Germany, Luxembourg, who exceeded 600 kg per person. Among the countries that generate the least amount of municipal waste are Poland (less than 300 kg per resident), the Czech Republic, and Slovakia (slightly over 300 kg per resident) (Eurostat, access May 12, 2017). The number of generated municipal waste in the year 2015 by European Union Member States is presented in Figure 1.

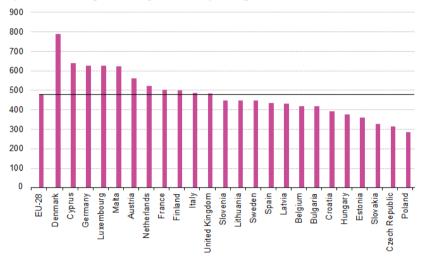


Figure 1. Municipal waste generated by European Union Member States in 2015

Source: Municipal Waste Statistic, Eurostat Statistic Explain, (2017) [available at: www.ec.europa.eu/eurostat/statistics-explained/index.php/Municipal\_waste\_statistics, access May 12, 2017]

The most popular method for managing municipal waste by European Union countries in 2015 was recycling (29%). However, a worrying fact is that as much as 28% of waste still ends up in landfills. Among the largest producers of municipal waste are countries that may pride themselves with the most effective ways of waste neutralization. High waste recycling and composting indicators can be seen in Germany - 68% (recycling + composting), Austria and Slovenia, 58% each (recycling + composting). Moreover, Germany is the European leader in landfilling municipal waste on dumps - only 1%. The ways of neutralizing waste by European Union Member States are presented in Figure 2.

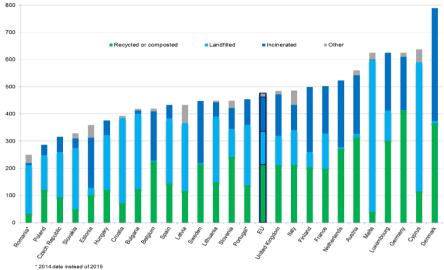


Figure 2. Municipal waste generated by European Union Member States in 2015

Source: Municipal Waste Statistic, Eurostat Statistic Explain, (2017) [available at: www.ec.europa.eu/eurostat/statistics-explained/index.php/Municipal\_waste\_statistics, access May 12, 2017]

From the above, it may be concluded that huge amounts of precious resources are wasted in Europe, and many countries are at risk of not fulfilling their obligations related to the specified recycling quotas. One of the methods for improving the situation may be enhancing the waste handling system by implementing ecoinnovations at individual stages of proceeding with municipal waste. This paper focuses on the analysis of eco-innovations as an effective tool of supporting the municipal waste management processes.

The aim of this article is to present the attitude of Polish entities engaged in waste management, i.e. companies dealing with segregation, transport, receiving, processing and disposal of municipal waste, as well as landfill operators, to eco-innovations. Moreover, it examines the possibilities and limitations of implementation and the use of eco-innovations. The first section presents the idea and definitions of eco-innovations, and a comparative analysis of eco-innovation-related data for Poland and other members of the European Union. The second part contains a presentation of the Polish eco-innovations in terms of waste management. The third part indicates the directions of necessary actions for increasing the number of eco-innovations in Poland, based on a survey.

#### 2. ECO-INNOVATIONS - BASIC INFORMATION

Literature on the subject includes numerous definitions of the phrase *eco-innovations*; one of the early ones was proposed by C. Fussler and P. James in 1996,

who claimed that "eco-innovation is a unique application of breakthrough changes that will work for satisfying the future needs" (Fussler & James, 1996, pg. 354). The following year, P. James offered a more specific characterization, and provided a classical definition of an eco-investment: "new products and processes which provide customer and business value but significantly decrease environmental impacts" (James, 1997, pgs. 52-57). In the subsequent years, this subject was touched upon by a number of researchers who formed their own understanding of the concept. Analysing the above definitions, it may be concluded that they lack a certain systematization, and that it is apparently justified to add the prefix "eco" to any innovation that is less dangerous to the environment than its alternative. An attempt to crystallize the idea was made by R. Kemp and P. Pearson, who saw eco-innovations as "products, production methods, procedures of exploitation of resources, ways of providing services, management methods that are new to the organization, and which ensure reduced environmental risk, emit less pollutions, consume more resources and cause less harm to the environment than the alternative solutions" (Kemp & Pearson, 2007, pg. 34).

This area has also become the focus of other entities, such as: the European Committee and the Organisation for Economic Co-operation and Development (OECD). The position of the European Union is particularly interesting, since it treats eco-innovations as any form of innovation in production processes, providing services and management methods leading to significant progress in the direction of implementing sustainable development principles. At the same time, such innovation is to lead to a reduced environmental footprint through preventing and reducing pollution, and to responsibly utilize natural resources (Report European Commission, 2008).

The above literary examples may be greatly summarized by the definition proposed by the OECD, which describes eco-innovations as "creating or introducing new, significantly improved products, processes, marketing methods, organizational structures and institutional solutions aiming at improving the condition of the natural environment, compared to the respective alternative solutions." (OECD, 2009)

Literature on the subject proposes numerous types of ecological innovations. In the report from surveys commissioned by the European Union as part of the Measuring Eco-Innovation (MEI) project, the following classification is employed (Kemp, 2010, pgs. 398-401):

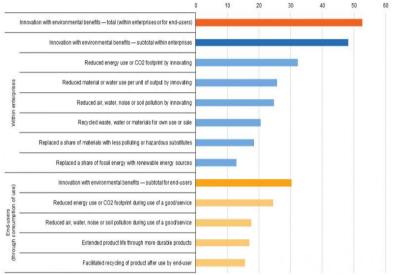
- environmental technologies,
- organizational innovation,
- product and service innovation,
- green system innovations.

In recent years a growing trend has be seen in research aimed at eco-innovation concerning production processes, new products or services. However, after analysing these innovative processes, it may be concluded that these are mostly growth-related innovations resulting from improvements to the production processes - rarely are they radical innovations. (Pujari, 2006, pg. 77) Defining the range between these types of innovations is very difficult, and the dividing criterion may be assumed to be the volume of knowledge and financial outlays on implementing the innovation, as well

as the resulting economic effects and consequences to the economy and enterprises introducing the new solutions (Forés & Camisón, 2016, pgs. 832-838).

The present state of environmental innovations can be found in European statistics. In years 2012-2014, nearly half of the enterprises operating within countries belonging to the European Union exhibited innovative activity (49.1%) in the scope of product, process, organizational and marketing solutions. The largest indicator was observed in Germany (67%), and the lowest in Poland (21%) and Romania (12.8%). Figure 3 presents the types of environmental benefits for enterprises and end-user, i.e., consumers, that result from implementing innovations.

**Figure 3.** Share of innovative enterprises that introduced innovations with environmental benefits within enterprises or for end-users in European Union, 2012–2014



Source: Eurostat, Innovation statistics [available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Innovation\_statistics, access May 12, 2017]

Nearly half (48.2%) of the innovative enterprises in the European Union introduced solutions providing environmental benefits. Almost one third (30.3%) of the countries implemented innovations bringing environmental benefits related to consumption or use of products and services. The most frequent benefits to the environment were limiting the consumption of energy and  $CO_2$  emission - 32.3%, reducing the volume of water and materials for producing a single unit - 25.7%, reducing noise and air pollution, water and soil contamination - 24.7%, use of waste sourced from recycling for own purposes or for further resale - 20.6%. Among the most frequently seen environmental benefits obtained during final consumption or through the use of the products and services are: limiting power consumption and  $CO_2$  emission - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%, reducing noise and air pollution, water and soil contamination - 24.5%.

17.6%, facilitating recycling of the product after use - 15.6%, increased product life - 17.1%.

One of the tools increasing the level of ecological innovations in Europe is the Eco-Innovation Scoreboard (Eco-IS). This index, through the use of 16 indicators divided into five subgroups (i.e., outlays on eco-innovation, actions related to ecological innovations, products for ecological innovations, effectiveness of the use of resources and social and economic performance), allows to identify strong and weak areas of ecological innovations in individual European Union countries (Arundel et al., 2009, pgs. 5-6). Figure 4 presents the eco-innovativeness indicator of each EU-28 economy in 2016. The leaders in this area are Germany, which reached a score of 140, and Luxembourg with 139 and Finland with 137. Poland is ranked 23rd, with its result of 72; this is due to the fact that in the sphere of eco-innovations, the country is poorly developing. However, it has made significant progress compared to its 27th place in the year 2015. One of the reasons for this was eco-innovation in the sphere of waste management.

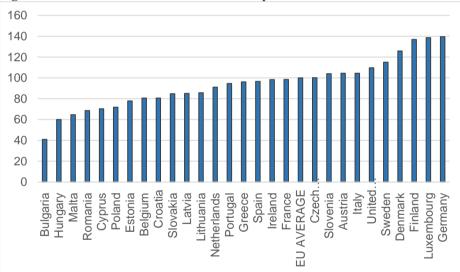


Figure 4. Eco-innovation Index 2016 in the European Union

Source: Giljum, Lieber & Doranova, (2017), European Union Eco-Innovation Index 2016report [available at: https://ec.europa.eu/environment/ecoap/sites/ecoap\_stayconnected/files/ eio \_brief\_eco-innovation\_index\_2016\_final.pdf, access May 17, 2017]

# 3. POLISH ECO-INNOVATIONS IN THE SCOPE OF WASTE MANAGEMENT

Technological, organizational and social eco-innovations can also be seen in municipal waste management processes (Rennings, 2000, pgs. 322-323). This paper will later discuss the above forms of eco-innovations, including examples of the solutions implemented in Poland.

Technological eco-innovations concern the use of a new technology or technique during the provision of municipal services, as well as during recycling, recovery and dumping of waste. An example of this type of innovation may be the use of a depolymerisation method, i.e. conversion of waste from plastics into liquid energy sources (oil, boiler fuel), which allows to obtain 80-85% of energy. This process is less harmful to the environment than burning waste which results in huge numbers of harmful substances, e.g. nitrogen oxides, phosgene, dioxides (Wołosiewicz-Głąb et al., 2016, pgs. 5-6).

Another example of an innovation used in the process of composting municipal waste is the use of aerated disposable foil sleeves in which an enclosed stabilization process takes place. This mechanical and biological procedure significantly reduces the release of methane to the atmosphere, and, thanks to the use of a system of pipes for distributing air into a bio-filter, it reduces the emission of undesirable odours. Moreover, thanks to its cycle time of about 8 weeks, it allows to save approximately 80% of the surface area, compared to the more frequently used bio-stabilization in prisms. This system has been successfully implemented in a dozen Polish cities (EIO, 2014-2015, pg. 9).

A very interesting and innovative solution bringing positive environmental and economic effects is the technology developed by the company Bioelektra, which consists of subjecting the waste to sterilization in specially designed hermetic containers. The waste content, under high temperature and pressure, decreases its mass, volume, as well as bacteria and parasite cultures. The process allows to separate raw materials, such as: glass, metal, plastic. Moreover, this fully ecological technology allows to obtain 99% effectiveness in recovering recycled resources in the sorting plant, reducing the waste processing plant size, investment outlays, and lowering operating costs per 1 MG of waste, as well as providing the possibility of processing unsegregated waste (Miller, 2016, pgs. 3-13).

The eco-innovative organizational solutions consist of providing waste management services in consideration of ecological aspects, as well the environmental footprint. One example of such solutions is the use of Geographical Information Systems (GIS) for making decisions relating to handling waste. This tool, based on computer technologies, allows to create, manage and analyse data in geographical space. The use of GIS provides the possibility of effectively managing the entire chain of deliveries, reducing waste volumes, while storing and processing them in a proper manner. It may be used for planning and defining waste management regions, optimizing collection times and waste truck routes (Gaska, Generowicz, 2014, pgs. 20-22). Another issue worth mentioning is an EU project named BURBA (Bottom-up selection, collection and management of URBAn waste), which was implemented, among others, in one Polish city. The project employs low-budget RFiD (Radiofrequency identification) technology and an LBS location system, which are integrated with an innovative IWAC waste container. It allows verifying the correctness of segregation, and removal of waste in the place of its occurrence. Through the use of residents' access cards allowing to open the bin lid, the inspecting authority receives information on the correctness of removing waste. Through a phone app, the same data are also received by users. Thanks to the use of these technologies, it is possible to introduce motivating waste handling programs, e.g. lowering payments for waste disposal (UK, 2015).

Social eco-innovations consist of including human capital in the environmental goals, and shaping and introducing pro-ecological patterns of behaviour (Miklińska & Klopott, 2016). In the scope of municipal waste disposal, an example of this may be local sorting plants in specially constructed pavilions for such purpose. According to the hierarchy of waste treatment, it managed at an early stage of its generation and acceptance. The EKO AB system, which is innovative and attractive from the point of view of environmental protection and the economy, is a solution used in two Polish cities (Płock, Bytom Odrzański). It provides very good results, e.g. recovery and sale of recycled resources, and recovery of waste directed for segregation - at a level of 75-80%, reducing the volume of waste directed for sorting to 20-25%. This system also ensures the fulfilment of the European Union Directive within the specified timeframe, lower payment for solid waste disposal per resident, new workplaces for persons with low occupational qualifications, as well as ones having problems with supplementing their labour history for retirement purposes (Bartoszkiewicz, 2013).

In Poland, there is a growing interest in new solutions with regard to ecological innovations. This can be seen in the amount of scientific research devoted to environmentally-friendly implementations. Many of them are aimed at efficient and ecological management of municipal waste. In addition, Polish companies are increasingly eager to use ecological innovations in the area of transport, collection and storage services for municipal waste.

#### 4. SURVEY FINDINGS

#### 4.1. Survey purpose and methodology

In order to accomplish the purpose of this article, the decision was made to conduct a survey among enterprises collecting waste, dealing with its segregation, recycling, processing, disposal, and managing dumps. Regionalization is the basis of the waste management system in Poland. The country is divided into 81 regions with 172 regional municipal waste treatment facilities. The study selected the 75 largest in terms of the weight of treated waste from regional processing plants and 75 companies involved in the collection and transportation of waste to these points.

The survey aimed at verifying the use of eco-innovations in performing the process of handling waste, and at showing the attitude of these entities to eco-innovations. A questionnaire was created with the use of a template provided by Google. In order to unify the concept of eco-innovation by respondents, the questionnaire started with a definition and classification. It consisted of 10 questions on the causes and types of eco-innovation and barriers and further plans to implement these solutions in the companies surveyed.

The questionnaire was sent to 150 companies dealing with municipal waste in Poland, and the response rate was 50%.

#### 4.2. Survey result

The survey finding was as follows:

- 67% of respondents use at least a single eco-innovative solution in providing their services related to handling municipal waste; the majority of recipients specified that these are technological and/or organizational innovations (92%),

- another inquiry was the reason for introducing the eco-innovation (multiple choice answer) - as many as 89% respondents pointed out that the main reason was the European Union's legal regulations relating to, among others, the means of transport (5 or 6 EUR standard in vehicles), and the necessity to increase recycling levels; moreover, 25 respondents specified pressure from an administrative commune as a reason - the communes want to present themselves as an eco-friendly region; 30 enterprises acted with the idea of lowering costs; 28 respondents introduced the new methods for the purpose of minimizing their environmental footprint,

- the eco-innovations used by the respondents only originate from European Union countries (about 32%), only from the domestic market (about 16%), outside Europe (4%), whilst 36% of the employed solutions come from the domestic and/or EU and/ or external EU market,

- 72% of the respondents notice economic benefits from the use of ecoinnovations; this mostly applies to transportation companies which, thanks to the use of carriage route optimization tools, reduced their fuel consumption,

- environmental benefits are identified by 48 of the surveyed enterprises, and 75% of them are regional waste handling stations which point out that the implemented eco-innovations cause a year-to-year reduction in the number of deposited waste, and an increase in the fractions submitted to recycling.

Concerning the willingness to implement further eco-innovations in the service-providing processes, the responses were as follows:

- a little over two-thirds of the respondents would willingly introduce new solutions on the condition of receiving subsidies, financial incentives, or external co-funding of their purchase,

- 52% of the respondents claim that eco-innovations may strengthen the competitiveness of their companies on the market,

- among the largest barriers are: excessive costs of technological investments (85%), too few purchase-financing programs (73%), current regulations and structures that fail to provide sufficient incentive to eco-innovation (60%), unsure return on investment, or too long a return period (48%),

- from the respondents' perspective, the most important parameters that should characterize new eco-innovations are: shortening the duration of transportation, collection, segregation, utilization process times - 72%, lowering the costs of these processes - 92%, reducing the negative impact on the environment - 45%, reduction in employment - 15%.

The respondents' answers also included claims that, despite increased financial outlays from the Innovative Economy Operating Program in years 2007-2011, the effects of the carried out actions will only be noticeable to a limited extent. However, the respondents are seeing large possibilities in the "Europe 2020" program, which puts a lot of emphasis on eco-friendly technologies.

Even though the entrepreneurs participating in the process of waste management in Poland currently use modern and eco-innovative solutions, the main reason for their implementation is the imposed European Union regulations. In their opinion, the important barriers include a lack of sufficient co-financing, and excessive costs of purchasing technologies. Despite these barriers, the Polish companies are still interested in implementing new solutions, on the condition of external subsidization. In their opinion, eco-innovations must, most of all, generate cost and time savings the ecological factor is of secondary importance. Eco-innovations are to be deemed an important issue, especially since the respondents see significant environmental and financial benefits from the solutions implemented so far. Modernization of the Polish process of managing municipal waste must be continued, so that the required levels of recycling and preparing of paper, metals, plastics and glass to re-use are achieved by 2020.

Poland has already taken a big step towards achieving these limits. The decreasing annual volume of generated municipal waste as well as the amount of waste entering landfills are evidence of this process. Thus, the experience resulting from the development of eco-innovation in Poland may undoubtedly constitute an example to follow for other countries. The solutions applied in Poland can be transferred directly to them and they could become an inspiration and determine the desirable course of development.

#### **5. CONCLUSION**

Eco-innovation aims not only at reducing the environmental impact, but also at increasing competitiveness and growth through more efficient use of natural resources. The use of eco-innovation in the area of waste management fosters the development of new processes, technologies and services that make businesses more environmentally-friendly and reduces operating costs. The EU has launched a number of programs that support eco-innovation but should speed up the process of practical implementation of good ideas. According to the survey conducted, Polish companies are willing to implement new ecological solutions provided financial support in their purchase is available. The next step will be to expand the research by increasing the number of respondents and covering the other cells involved in the waste management process in Poland, i.e., resellers and dealers in waste management.

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### IX. INTERDISCIPLINARITY IN LOGISTICS PRACTICE

### ANALYSIS OF LOGISTIC PERFORMANCE IN SOUTHEAST EUROPEAN COUNTRIES

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#### Abstract

The logistic capability of a region or a country is of outmost importance to its economic competitiveness. Hence, the basic goal of this study is to explore the logistic capability in Southeast European countries by applying the LPI methodology. This methodology provides the analysis of aggregate factor of logistic capability, as well as of individual indicators that constitute the index. The goal of the research is to establish a level of correlation between the aggregate factor of logistic performance and its constitutive indicators, but also the strength and direction of correlation between each of these individual indicators and global index of competitiveness. The research will focus on recognising the individual indicators that have a direct and relevant impact on the competitiveness of each country and of the whole region. The suggested frame of research could help in decision-making by providing a basis for better assessment of competitive advantages and the development of individual indicators that form the index of logistic performance.

**Key words:** logistic performance index (LPI), global competitiveness index (GCI), Southeast European countries

#### **1. INTRODUCTION**

Logistics is a high cost activitie and usually represent the prerequisite for economic development or an important development accelerator. Also, logistics infrastructure is an integrating factor within a territory. The logistics infrastructure of Southeast Europe is an important segment of the European macro-logistic system. This is confirmed by the presence of five Paneuropean corridors (IV, VII, VIII, IX and X), and ofshoots of corridors V, Vb and Vc in this area. These corridors are in function of creating a singular transport and logistics European network, but also provide a better connection between each of the Southeast European countries and their connection with the rest of Europe, as well as higher efficiency of their logistic and economic systems.

Efficiency of a country's logistic system is measured by the index of logistic performance. This research initiates from the implied importance of a developed logistic system in economic functioning of a country or region and so the focus will

be on all of the six indicators that form the logistic performance index by applying the method of analysis and synthesis, the comparative method, and the method of descriptive and inferential statistics. Such an approach will provide the recognition of those individual indicators that directly and significantly influence the competitive capability of the countries and region as a whole. The results are based on secondary data resources, that is the World Bank LPI and GCI reports.

#### 2. RESEARCH PROBLEMS

Southeast European countries (Albania, Bosnia and Herzegovina, Bulgaria, Greece, Croatia, Macedonia, Montenegro, Serbia, Slovenia and Romania) represent the economic, transportation and logistic perifery of Europe. With a global competitiveness index of 4,44, Bulgaria is positioned as the 50th out of 138 countries. However, in 2016, Bulgaria had the highest global competitiveness index in Southeast Europe, while Bosnia was at the back, with a global competitiveness index of 3,80 and thus was placed as 107th. Similar results are obtained if these countries are observed within global framework. Greece is placed at number 47 out of 160 countries, while Montenegro is the worst, placed at 123. Accordingly, it seems appropriate to examine the relation between the logistic development of Southeast Europe and their global competitiveness.

Designing a logistic network, i.e. pinning down the number of the necesssary logistic centres (NLC), Zelenika and Pavlić (2007,384) see this as a mathematical function of the number of inhabitants (P), surface or the gravitational area that needs to be covered (A), the level of economic development measured in GDP/p.c., the development of transport branches (TM) and roadways (TC):

NLC= f (P, A, GDP/p.c., TM, TC)

(1)

In line with this, the conclusion would be that the development of economic and transportation systems is a prerequisite for the development of a logistic system. Segetlija (2002,269) asserts the following general conditions for formation of an international logistic system: transportation distances, means of transport, institutions, documents, information etc. Vittorio d'Aleo (2015) explores the role of the logistic performance index as a mediator variable between the global index of competitiveness and the GDP of EU28 countries, and concludes that improvements in logistic system have a positive effect on the growth of national wealth and that the logistic performance index may serve as a good predictor of the GDP movement. Zekić, Samaržija and Pupavac (2017) evaluate that a country's competitiveness is influenced by the LPI in global terms at different levels of economic development. Their conclusion is that factor-driven economies should focus on macro-logistics, while the efficiency-driven economics should be oriented towards developing micrologistics system. The innovation-driven economies should invest in maintaining existing and developing new infrastructure based on information and communication technologies. Pupavac and Golubović (2015) assert the importance of logistics in economic activities and determine the existence of a firm and positive relation between the movement of logistic performance index as a composite notion and the global competitiveness index. Unlike the aforementioned researches, this one will attempt to determine the level of correlation between the aggregate indicator of logistic performance and its constitutive factors, as well as the correlation between each of these factors and the global competitiveness index.

One of the fundamental problems in logistic systems of Southeast Europe arises from the fact that Albania, Macedonia, Bosnia, Montenegro and Serbia are not members of the European Union, and that they will not be any time soon. This significantly slows down the flow of transport and goods, increases logistic expenses, decreases the productivity of transportation and logistic companies and complicate the management of a common cohesive transport and logistic policy. This is also the main reason for underutilisation of corridor X (cf. figure 1), incidentally, the corridor with the biggest potential for connecting the countries of Southeast Europe and for connecting them with the Western and Northwestern Europe.



Source: authors prepared according: Balkan railways, From Berlin to Beijing, The Economist, Sep. 16, 2010.

With this in mind, the representatives of national railways from Croatia, Serbia and Slovenia have founded a common company in 2010, Cargo X. Montenegro and Macedonia have declined to be a part of this partnership. Founding a common company meant approaching the goal of quicker transportation of goods on the Paneuropean transport corridor X and an increase in its competitiveness in relation to corridor IV. If transport time would be shortened from 60 to 25 hours ride, transport of goods from corridor IV might be transferred to corridor X. There are about 700 trains on relation Ljubljana-Zagreb-Belgrade-Dimitrovgrad-Istanbul within corridor

X, while there are about 7000 trains within the corridor IV, which is also longer and passes through Hungary. It is in the interest of parties within corridor X to attract a number of trains from corridor IV (Zuko, 2011).

A separate problem is the railway system in countries of Southeast Europe. Its infrastructure is obsolete, non-electrified and consists of mostly one-track railways, technical standards of the TEN-T network are insufficient, narrow passages are common and generally, the uncompetitiveness of the railway system is severe. Uncompetitiveness disables application of modern technologies and significant development of multimodal transportation. Underdevelopment of multimodal transport where railway is only of slight importance negatively affects the development of logistic activities related to transport and distribution. Undeniably, the majority of mega-logistic and macro-logistic centres should be located on main transport routes, that is corridors, and in gravitational areas of seaports, river ports and airports (Zelenika, Pavlić, 2007, 384).

Insufficient exchange of goods between the countries of Southeast Europe and almost exclusively nationally oriented transportation and logistic systems restrain these countries' full exploitation of their transport, logistic and economic potentials. Only Pireus in Greece has managed to position itself among the top 20 European cargo ports (on number 8) with 3,58 million of containers, and in 2015 Romanian Constantza 56.3 of (on number 15). with million tons cargo (www.portofrotterdam.com). National profiling of Southeast European ports' transport and logistic systems is confirmed by the amount of traffic in their largest ports, as in the Albanian Durres, Bar in Montenegro or Varna and Burgas in Bulgaria. The same could be said for Rijeka, Croatian most significant port. Cargo transport in Rijeka is dependent on the movement of GDP, which did not change even after Croatia became member of the European Union. This is confirmed by the following correlation analysis between the total cargo transport of the Port of Rijeka, its container terminal and Croatian GDP in the period 2000-2016 (cf. Table 1).

		GDP value
Total cargo	Pearson's correlation coefficient	0,68
transport	P value	0,002365
TEU transport	Pearson's correlation coefficient	0,86
_	P value	0,000006

**Table 1.** Correlation between Port of Rijeka's total cargo transport, container terminal and Croatian GDP.

Correlation is significant on 0,01 level Source: authors' calculation

The figure 2 also shows that PoR (Port of Rijeka) remained predominantly the port of Croatia, Serbia and Bosnia and Herzegovina.

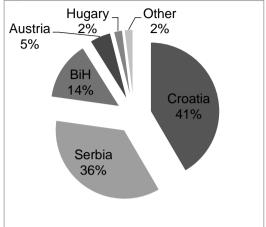


Figure 2. Turnover at the PoR's container terminal per country

Source: authors prepared according to ICTSI 2017, http://www.ictsi.com (13.05.2017.)

Progress of the entire logistic system in the countries of Southeast Europe is an important factor of region's competitiveness and of its more acute inclusion in the global flow of goods. Logistic performance index is a means of measuring logistic performance of a particular country. It provides a means of comparison between 160 countries in six domains: (1) efficiency of the clearance process by customs and other border agencies; (2) quality of transport and information technology infrastructure for logistics; (3) ease and affordability of arranging international shipments; (4) competence and quality of logistics services; (5) ability to track and trace international shipments; and (6) timeliness of shipments in reaching destination.

In order to analyse and evaluate logistic capability of countries in Southeast Europe, the following information could be of help (cf. Table 3.):

					Interna- tional	Logisti-cs		
Country	LPI rank	LPI score	Customs	Infra- strcture	shipm- ents	compe- tence	Tracking & tracing	Timeli- ness
Country	Talik	score	Customs	sticture	ents	tence	tracing	ness
Greece	47	3,24	2,85	3,32	2,97	2,91	3,59	3,85
Slovenia	50	3,18	2,88	3,19	3,10	3,20	3,27	3,47
Croatia	51	3,16	3,07	2,99	3,12	3,21	3,16	3,39
Romania	60	2,99	3,00	2,88	3,10	2,82	2,95	3,22
Bulgaria	72	2,81	2,40	2,35	2,93	3,06	2,72	3,31
Serbia	76	2,76	2,50	2,49	2,63	2,79	2,92	3,23
BiH	97	2,60	2,69	2,61	2,28	2,52	2,56	2,94
Macedonia	106	2,51	2,21	2,58	2,45	2,36	2,32	3,13
Albania	117	2,41	2,23	1,98	2,48	2,48	2,15	3,05

Table 3. LPI rank, LPI value and values of LPI indicators.

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Montenegro	123	2,38	2,22	2,07	2,56	2,31	2,37	2,69
Average_se10		2,80	2,61	2,65	2,76	2,77	2,80	3,23
Average_160		2,88	2,72	2,75	2,87	2,82	2,86	3,27
Average top10		5,37	4,01	3,86	4,08	3,99	4,08	4,25

Source: authors prepared according 2016 LPI, https://lpi.worldbank.org/international/global (15.03.2017.)

According to data in Table 3, only three out of ten countries have LPI>3 and that indicates the uncompetitiveness of these countries. LPI values range from 1 (worst) to 5 (best) and show that developing the capacity to connect firms, suppliers and consumers is a key in a context where predictability and reliability are becoming as important as costs in sourcing decisions. A value of less than 3.0 usually reflects an array of problems within a nation's freight distribution system causing undue delays and additional costs. For instance, a difference of one point lower in the LPI is related to two to four additional days of port hinterland access and a 25% higher physical inspection rate at customs. Table 3 also shows that Southeast Europe significantly lags behind the top ten countries (with highest LPI), but also on a global level, which is especially worrying. This lag is visible in every area that constitutes LPI.

#### 3. DATA AND RESEARCH METHODOLOGY

Data is obtained from the LPI Global Rankings 2016 surveys, conducted by the World Bank in partnership with academic and international institutions and private companies and individuals engaged in international logistics. Second source of data is The Global Competitiveness Report 2016-2017. The GCI includes an average of many different components, each measuring a different aspect of competitiveness. This study applied desk research scientific methods: methods of analysis and synthesis, comparative method, methods of descriptive and inferential statistics. Numeric calculations are performed using the Statistica software.

#### 4. RESEARCH RESULTS AND DISCUSSION

Correlation analysis for 160 world countries was carried out using the Statistica software, to determine the level of correlation between the aggregate logistic performance index and its constitutive indicators. The results are shown in Table 4.

	Means	Std.Dev.	LPI	Customs	Infrastruc	Internati- onal shipments	competen-	Tracking & tracing	Timeliness
LPI	2,883	0,6272	1,000	0,963583	0,975845	0,965969	0,981540	0,976455	0,959787
Customs	2,715	0,6409	0,963	1,000000	0,943819	0,918808	0,932734	0,928468	0,903137

**Table 4.** Correlation analysis between LPI and its indicators.

Infrastructure	2,754	0,7190	0,975	0,943819	1,000000	0,926196	0,961143	0,944117	0,909110
International shipments	2,866	0,5744	0,965	0,918808	0,926196	1,000000	0,939090	0,924880	0,916664
Logistics competence	2,824	0,6452	0,981	0,932734	0,961143	0,939090	1,000000	0,953064	0,926110
Tracking & tracing	2,863	0,7009	0,976	0,928468	0,944117	0,924880	0,953064	1,000000	0,938997
Timeliness	3,268	0,6197	0,959	0,903137	0,909110	0,916664	0,926110	0,938997	1,000000

Source: Source: authors' calculation

Data from Table 4 show a strong and positive correlation between the LPI and all its indicators. Correlation between the LPI and logistic competence (r=0,98), between the LPI and tracking and tracing (r=0,97) and between the LPI and infrastructure (r=0,97) have the highest Pearson's correlation coefficients. With these indicators standard deviations are the largest (infrastructure-SD=0,719; tracking & tracing-SD=0,7; logistics components-SD=0,645), also variations (infrastructure-s=0,517; tracking & tracing-s=0,49; logistics competence-s=0,416) and coefficients of variations (infrastructure-CV=26,1; tracking & tracing-CV=24,47; logistics competence-CV=22,84). This indicates the importance of these three indicators in the increase of logistic capabilities in the systems of Southeast Europe.

Analytical relationship between individual LPI indicators and GCI in 160 world countries can be shown as follows (Table 5):

Regression Summary for Dependent Variable: LPI R= ,99961056 R <sup>2</sup> = ,99922127 Adjusted R <sup>2</sup> = ,99917917 F(6,111)=23738, p										
	b*	Std.Err of b*	b	Std.Err of b	t(111)	p-value				
Intercept			-0,004920	0,011321	-0,43458	0,664714				
Customs	0,134890	0,008787	0,131586	0,008572	15,35076	0,000000				
Infrastructure	0,181227	0,011390	0,157629	0,009907	15,91127	0,000000				
International shipments	0,177211	0,007866	0,196019	0,008701	22,52768	0,000000				
Logistics competence	0,203096	0,011867	0,197621	0,011547	17,11381	0,000000				
Tracking & tracing	0,163663	0,011363	0,146270	0,010155	14,40364	0,000000				
Timeliness	0,169177	0,008574	0,170626	0,008648	19,73098	0,000000				

Table 5. Regression analysis of LPI and its individual indicators

Source: authors' calculation

The regression analysis shows that logistics competence  $b^{*}=0,203$ ) and infrastructure ( $b^{*}=0,181$ ) have the largest beta coefficients and this additionally asserts the importance of the two in the increase of logistic capabilities in the countries of Southeast Europe.

The correlation between the LPI and its individual indicators can be shown mathematically as follows:

$$LPI = -0,00492 + 0,135C + 0,181I + 0,177IS + 0,203LC + 0,163TT + 0,169T$$
(2)

Accordingly, from this point on, this research will explore the strength and direction of correlation of each indicator forming the LPI and the global index of competitiveness. The results of correlation analysis for the available 118 countries are shown in Table 6:

	GCI	Customs	Infrastr- ucture	International shipments	Logistics competence	Tracking & tracing	Timeliness
GCI	1,000000	0,836926	0,877338	0,822326	0,878295	0,855783	0,834294
Customs	0,836926	1,000000	0,943231	0,905248	0,928509	0,928809	0,910299
Infrastructure	0,877338	0,943231	1,000000	0,913886	0,960884	0,950309	0,918643
International shipments	0,822326	0,905248	0,913886	1,000000	0,927069	0,920775	0,909824
Logistics competence	0,878295	0,928509	0,960884	0,927069	1,000000	0,959078	0,927898
Tracking & tracing	0,855783	0,928809	0,950309	0,920775	0,959078	1,000000	0,940617
Timeliness	0,834294	0,910299	0,918643	0,909824	0,927898	0,940617	1,000000

Table 6. Correlation analysis between LPI and GCI.

Source: authors' calculation

Data in Table 6 show a strong and positive correlation between all the individual indicators that constitute the LPI and GCI. The strongest correlation is between logistics competence and GCI (r=0,981), and between infrastructure and GCI (r=0,877). Also, this indicates the importance of the two in increasing the economic competitiveness of Southeast Europe. Analytic correlation between the individual indicators of the LPI and the GCI can be shown as follows (Table 7).

Regression Summary for Dependent Variable: GCI (Sve_LPI_GCI) R= ,88690388 R <sup>2</sup> = ,78659850 Adjusted R <sup>2</sup> = ,77495842 F(6,110)=67,577 p										
	b*	Std.Err of b*	b	Std.Err of b	t(110)	p-value				
Intercept			1,574235	0,209280	7,522144	0,000000				
Customs	- 0,018839	0,144901	-0,020373	0,156705	-0,130010	0,896796				
Infrastructure	0,436280	0,188338	0,419817	0,181231	2,316479	0,022385				
International shipments	- 0,032013	0,129711	-0,039350	0,159437	-0,246803	0,805521				
Logistics competence	0,449697	0,196717	0,484013	0,211728	2,286009	0,024169				
Tracking & tracing	- 0,016805	0,187493	-0,016673	0,186027	-0,089628	0,928746				
Timeliness	0,078318	0,141191	0,087731	0,158161	0,554693	0,580231				

**Table 7.** Regression analysis of GCI and individual indicators of LPI

Source: authors' calculation

The regression analysis confirmed the statistically significant influence of the two indicators on the LPI and GCI: infrastructure and logistics competence. In order

to obtain the conclusive mathematical model, regression analysis for these two indicators and the GCI was conducted. The results are shown in Table 8:

Regression Summary for Dependent Variable: GCI (Sve_LPI_GCI) R= ,88653504 R <sup>2</sup> = ,78594437 Adjusted R <sup>2</sup> = ,78218901 F(2,114)=209,29 p												
b* Std.Err of b* b Std.Err of b t(114) p-value												
Intercept			1,615890	0,149632	10,79908	0,000000						
Infrastructure	0,435423	0,156462	0,418992	0,150558	2,78292	0,006307						
Logistics competence	0,459904	Logistics competence 0,459904 0,156462 0,494999 0,168402 2,93939 0,003982										

**Table 8.** Regression analysis between infrastructure, logistics competence and GCI

Source: authors' calculation

According to obtained data, the following mathematical model can be written thusly:

GCI=1,61589+0,418992I+0,494999LC

Based on the presented global model, the evaluation of global competitiveness index for each of the Southeast European countries can be made, with emphasis on the aforementioned two indicators, if infrastructure and logistics competence would grow to the average level of the two indicators in the top ten countries based on LPI.

Predicting Values for	(Sve_LPI_	GCI) varia	able: GCI
	b-Weight	Value	b-Weight - * Value
Infrastructure	0,418992	3,860000	1,617310
Logistics competence	0,494999	3,990000	1,975047
Intercept			1,615890
Predicted			5,208247
-95,0%CL			5,091982
+95,0%CL			5,324512

Table 9. Evaluation of average GCI value in Southeast Europe

Source: authors' calculation

The conclusion, according to the obtained data in Table 9, is that if Southeast Europe's average values of two indicators – infrastructure and logistic competence – would rise to the average values of the LPI top ten countries, their average GCI of 4,14 would rise to 5,21 and so would be among the most competitive economies in the world.

#### **5. CONCLUSION**

The logistic performance index is a way of measuring the logistic efficiency of countries. LPI values range from 1 (worst) to 5 (best). Three out of ten countries in Southeast Europe have the LPI>3, and this indicates their uncompetitive logistic

(3)

systems. The average LPI of these countries is 2,80, i.e. below the global average of 2,88. LPI provides the comparison of 160 world countries in the six following domains: (1) efficiency of the clearance process by customs and other border agencies; (2) quality of transport and information technology infrastructure for logistics; (3) ease and affordability of arranging international shipments; (4) competence and quality of logistics services; (5) ability to track and trace international shipments; and (6) timeliness of shipments in reaching destination. The comparative analysis has asserted the lag of Southeast Europe in all the six domains when compared to global average. This lag is even larger if compared to the LPI top ten countries.

The correlation analysis has asserted a strong and positive correlation between the LPI and all of its indicators. The highest coefficient of correlation occurred between the LPI and logistic competence (r=0,98), between the LPI and tracking & tracing (r=0,976) and between the LPI and infrastructure (r=0,975). Regression analysis has additionally emphasized the importance of infrastructure and logistic competence in advancement of logistic performances. Also, a strong and positive correlation between the two indicators of LPI and GCI was asserted. Regression model has confirmed that if Southeast Europe's average values of two indicators – infrastructure and logistic competence – would rise to the average values of the LPI top ten countries, their average GCI of 4,14 would rise to 5,21 and so would be among the most competitive economies in the world.

The main defect of this study arises from the fact that evaluations were made from observing the undeniable growth of the two indicators of LPI and GCI of Southeast European countries without making a proper research for the period between 2007 and 2016 to establish if the values of LPI were divergent or convergent between the developed and undeveloped countries. Future researches may focus on the process of divergence or convergence in the LPI of differently developed countries, but also in individual domains of the LPI.

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### PROFITABILITY OF PARTICIPANTS IN SUPPLY VALUE CHAIN IN CROATIA

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#### Abstract

The management system in supply value chain covers wide range of activities. The goal of the implementation of the system is to create strong value in the process between producers and final customers or consumers. In recent years, Croatian economy was faced with many significant changes in profitability of its participants. Production, distribution and retail sector had passed through significant changes since 2009. Production sector decreased -12.3% in 2009 compared with the same period of previous year, afterwards wholesale, distribution and retail sector decreased -11,6% compared with year 2008. The economic crises from 2009, caused by crises of mortgage loans in United States of America, left significant consequences on Croatian economy as well (GDP decreased -7.4%). The movements of consumer's preferences and habits changed rapidly in period of recession from 2009 to 2014. Nevertheless, the changes in consumer preferences and habits had an impact on other key players in the chain. The players are: producers, distributors and retailers. According to all mentioned facts, the main subject and the goal of this Paper is to analyse profitability of each participant in the supply value chain. Focus is on Croatian producers in Food and Beverage industry (National Classification of Activities abbreviation NKD C10 and NKD C11), distributors (NKD G46.90 and NKD G46.36) and retailers (NKD G47.11 and NKD G47.19). The hypothesis in this paper is emphasizing the disproportionately in division of a profitability between main players in value chain, where producers are the most negatively affected. The paper analysis TOP 10 participants in production, distribution and retail sector. The period which was taken into observation in this paper is 2011 - 2015, together with data from 2016 (only the companies listed on Croatian stock exchange market). The identified trend is the same for 2016 as for the period 2011 - 2015.

*Key words:* profitability, supply value chain, food and beverage industry sector, distribution, retail

#### **1. INTRODUCTION**

Supply chain management presents processes between producers, distributers, retailers and finally consumers. All participants in value chain must take care about their efficiency. The supply chain is facing with constant restructuring process, because of unstable market conditions. Processes are becoming more and more transparent by decreasing the number of suppliers<sup>1</sup>, which leads to modification of business strategies. Creating a new added value and sharing it among partners is the key process in any organisation. The establishment of more efficient supply chain is becoming one of the key business goals. The Japanese were the first to recognize the importance of this process. Rationalization and acceleration of the movements between the participants in value chain are becoming one of the most important components of competitive advantage of modern market.

The efficient functioning of the supply chain includes effective and fast circulation of the information.

The supply value chain can be extended as much as its participants allow it. Producers, distributors, retailers and final consumers are depending on each other, because they present circular economy where one is purchasing while other is buying the same goods and services<sup>2</sup>.

In addition, it is important to analyse an open organisational architecture which represents an effective tool for improving competitiveness and presents important role in globalisation and modern economy.

Furthermore, it is also important to emphasise other forms of market structure in the supply chain, such as vertical supply system based on transaction costs within closed supply chain<sup>3</sup>.

In Croatia, there are several important vertical integrated systems (e.g. Agrokor). In the modern economy, closed supply system based on vertical integration are losing in profitability while increasing business risk because of the high system complexity. The Croatian economy experienced the first significant changes after mortgage crisis in 2008 in USA market, and their transmission on Croatian market in 2009. Consumers preferences changed drastically. During the recession from 2009 to 2014, consumer habits and the way of production, distribution and retailing has experienced with one kind of transformation which left serious consequences on overall economy and profitability in the supply chain. The trend of decreasing of GDP in the last six years, has affected on many structural changes in the market and caused a spiral of psychological suspense. The saving rate form 2009 – 2014 had been increased for 26,6% in terms of foreign exchange deposits and 17,1% for deposits overall. In the same time, the monetary expenditure measured in terms of household loans had been decreased for  $-2,5\%^4$ . The total GDP in 2016 was slightly as GDP in

<sup>4</sup> Croatian national bank, Foreign liabilities of other monetary financial institutions,

<sup>&</sup>lt;sup>1</sup> Number and structure of business entities, December 2015, NSO, NUMBER: 11.1.1/4.

<sup>&</sup>lt;sup>2</sup> David J. Bloomberg, Stephen B. LeMay, Joe B. Hanna, Logistics, 1st edition, Prentice Hall, 2002, page

 $<sup>\</sup>frac{1}{3}$  Williamson, O. E. (1979), Transaction-Cost Economics: The Governance of Contractual Relations, Journal of Law and Economics, 22, 233-261.

https://www.hnb.hr/en/statistics/statistical-data/other-monetary-financial-institutions/consolidated-balance-sheet

2005, measured in constant prices. In other words, the total real GDP contraction was over 8% in 2016 compared to 2008.

All mentioned factors influenced on behaviour on the participants of the supply value chain. The final consumers became more cautious while purchasing in the recent years. As their answer on changes in consumer preferences, distributors and retailers acted by adapting their assortment and their market positions within new circumstances. Strong penetration of private brands, together with brand erosion, dumping prices and several other factors had led to significant corrections in supply chain. However, domestic producers have suffered the most in the period of crises. Due to the constant pressures on producer price from the other participants in value chain, producers were forced to decrease their margins in order to keep competitive position on the market. Other very important reason is strong penetration of foreign retail chains preferably discounter. The main discounter in Croatia contains more than  $80\%^5$  of private brands and keeps  $9\%^6$  of total market share in 2015 with strong base of international suppliers. Afterwards, last but not at least reason is tariffs, where the most products became cheaper after the year 2013.

The main hypothesis in this paper emphasize the disproportionately in division of a profitability between main players in value chain, where producers are the most negatively affected. The analysed period is 2011 - 2015, with special emphasis on 2013, when Croatia joined the EU.

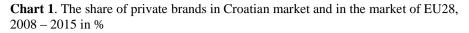
#### 2. SITUATION IN FOOD INDUSTRY SECTOR, NKD C10 AND NKD C11

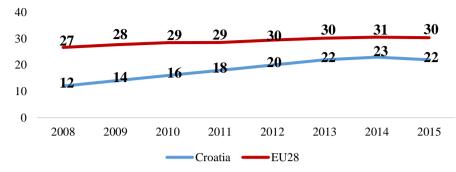
In gross domestic value added, the food industry is one of the most important sector. Following the agriculture, the food industry is one of the first steps in creating value on the market. In 2016, food industry made 44.2 bn Kuna in total gross domestic value added, which represents around 15,3% of total gross domestic value added and employs 208.375<sup>7</sup> employees (17.8% of total employees in Croatia). After joining the EU, first of July 2013, Croatia has passed through significant structural changes, especially in food industry. The strong pressure from foreign competitors, using discounting and dumping prices together with contraction of household income had significantly influenced on consumers habits and preferences. All those mentioned facts caused changes in profitability of food sector in Croatia. Due to the recession and decline in personal consumption, the private brand share has increased. When in 2014 Croatia exit from recession, the trend of high penetration of private brands began slightly to decrease in total portfolio of retail chains in Croatia.

<sup>&</sup>lt;sup>5</sup> GFK retail monitor March 2016

<sup>6</sup> GFK retail monitor March 2016

<sup>&</sup>lt;sup>7</sup> Active population (labour force) in Republic of Croatia, according to administrative sources, by sex – final table 9.1.5., April 2017, Croatian bureau of statistics (CBS)





Source: GFK retail monitor household panel March 2016 and MAT June, Nielsen shopper trends in Croatia 2016

The chart 1 above shows the effect of market share convergence of private brands in Croatia compared with market share in EU28. The trend lines between the curves, after 2013 are reaching a strong correlation. In the last 3 years, the private brand share in Croatia is 22% and in the EU 28, is around 30% in the same period.

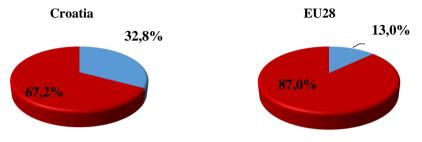
# 3. MARGINAL PROPENSITY TO CONSUMPTION ON FOOD AND BEVERAGE

The share of consumption on food and beverage in total household income depends mostly on the level of development of each country. For example, an average household consumption in 2014 (average household is 2,86 members per household) reached 81.315 Kuna<sup>8</sup>. In total consumption, marginal propensity to consumption on food and beverage equalled 33%. In the same time in EU28, marginal propensity to consumption was 13% of total consumption. All this facts show that Croatia is far below the EU28 average.

When the income increases and when the country achieves economic progress, the share of household consumption on food and beverage in total household consumption will decrease. According to this fact, Croatian economy will be achieve in the middle/long run the same level of development as the EU28 (convergence effect) and the marginal propensity to consumption will be on the level of EU28.

<sup>&</sup>lt;sup>8</sup> Results of Household Budget Survey, 2014, date of realised 29th april 2016, CBS

**Chart 2.** The share of consumption on food and beverage in Croatia and EU28 in year 2014



Source: CBS, Eurostat

At the same time, the countries of Adria region are reaching higher share of household consumption on food and beverage comparing to Croatia. Serbia has 41,4% share of total household consumption on food and beverage, Bosnia and Hercegovina has around 39,5% household consumption on food and beverage while Slovenia has around 14,9% share of household consumption on food and beverage. Developed countries such as Luxemburg, Switzerland or Norway have less than 10% share of total household consumption on food and beverage.

# 4. BUSINESS ANALYSIS OF TOP 10 FOOD AND BEVERAGE COMPANIES 2011- 2015 (NKD C10 AND NKD C11)

After Croatia joined the EU in July 2013, food and beverage sector became one of the most exposed. The important changes in the profitability occurred after the liberalization of the market and exponential growth of fair and un fair competition. The import of food products increased significantly in 2013, while export was decreasing. The result of emphasized statements was that Croatia, and mainly food industry didn't manage to adapt to a new market circumstances, at least in the short run.

From TOP 10 analysed companies from food and beverage sector, 7 of them have recorded continuous decline in profitability in observed period. The effect was even stronger after 2013, when Croatia joined the EU.

From table 1 it is visible that after the 2013 the level of gross margin is started decreasing. The weighted average of TOP 10 companies is viewed as the most relevant indicator, and the gross margin in 2013 was 25.2%, while in 2015 was 23.6%, therefore the profitability decreased by 1,6pp. The biggest decline in profitability was recorded in the beverage sector (Jamnica and Zagrebačka pivovara).

Rank 2015	Company	2011	2012	2013	2014	2015
1	Vindija	11,2%	11,4%	10,8%	11,1%	12,7%
2	Pik Vrbovec	17,1%	17,1%	20,3%	22,6%	19,5%
3	Podravka	35,6%	37,6%	36,7%	37,5%	35,3%
4	Dukat	20,4%	20,7%	17,7%	17,7%	17,2%
5	Jamnica	38,0%	37,3%	45,6%	35,7%	31,3%
6	Ledo	30,5%	32,5%	33,0%	33,5%	31,6%
7	Koka	22,0%	22,8%	17,8%	18,6%	19,0%
8	Pivac	13,6%	11,7%	14,3%	15,6%	15,0%
9	Zag. pivovara	61,8%	60,6%	60,2%	55,7%	56,0%
10	PPK Karlovac	9,7%	8,8%	9,6%	10,7%	10,2%
	Average TOP 10	24,4%	24,4%	25,2%	24,4%	23,6%

**Table 1.** Analysis of the approximate gross margin<sup>9</sup> of TOP 10 companies in the food and beverage sector

Source: Lider 1000 the biggest by the total revenue in 2015, boniteti.hr, authors analysis

**Table 2.** Analysis of the approximate EBITDA margin of TOP 10 companies in the food and beverage sector

Rank 2015	Company	2011	2012	2013	2014	2015
1	Vindija	3,3%	3,1%	2,9%	2,6%	3,1%
2	Pik Vrbovec	9,1%	9,7%	7,4%	8,0%	8,5%
3	Podravka	6,5%	5,7%	4,1%	10,7%	9,0%
4	Dukat	8,9%	7,4%	3,3%	5,1%	4,0%
5	Jamnica	14,1%	14,0%	26,6%	12,5%	11,6%
6	Ledo	13,1%	13,3%	13,3%	12,7%	13,4%
7	Koka	5,2%	6,8%	2,8%	3,2%	3,4%
8	Pivac	6,4%	4,6%	6,0%	8,3%	7,1%
9	Zag. Pivovara	39,6%	37,3%	35,7%	31,0%	30,0%
10	PPK Karlovac	3,6%	3,6%	4,4%	5,7%	5,1%
	Average TOP 10	9,6%	9,1%	9,3%	8,7%	8,5%

Source: Lider 1000 the biggest by the total revenue in 2015, boniteti.hr, authors analysis

The profitability measured by the EBITDA margin<sup>10</sup> had a significant decline after the liberalization of the market and Croatian accession to the EU. The average EBITDA margin for TOP 10 companies in the food and beverage sector was around 9.3% in 2013, while in 2015 decreased to low 8.5%. The most significant generator

<sup>&</sup>lt;sup>9</sup> Gross margin = (operating revenue-material costs) / operating revenue

The gross margin is approximated and calculated based on public available financial statements (source:FINA and www.boniteti.hr)

<sup>&</sup>lt;sup>10</sup> EBITDA margin = (operating revenue-operating expenses + depreciation) / operating revenue

of decreasing in profitability is the beverage industry. On the other hand, the dairy industry, the meat industry and Podravka<sup>11</sup> company recorded growth in profitability measured by EBITDA margin. One of the reasons for their positive performance is cheaper access to raw materials in EU market after the market liberalization and optimization in business process among some of the companies<sup>12</sup>. It is important to mention that most of the observed companies have their own distribution, so they don't need to use outsource distribution services.

# 5. SITUATION IN WHOLESALE AND DISTRIBUTION SECTOR, NKD G46.90 AND NKD G46.36

The distribution sector as a second player in the supply value chain is one of the most important sectors in overall economy. Only wholesale and distribution sector (NKD 46.90) employed 65.459 people in 2016 year and accounted for 3,6% of total employees in Croatia. In 2016, wholesale and distributive sector generated the total turnover over 100 bn Kuna. In the same year, the wholesale distribution sector together with retail, transport, storage, traffic and food service (NKD G,H,I<sup>13</sup>) measured as a share in total gross domestic value added, equalled 22,5% or 65.1 bn Kuna in total domestic gross value added.

# 6. BUSINESS ANALYSIS OF TOP 10 COMPANIES IN DISTRIBUTION SECTOR (NKD G46.90 AND NKD G46.36) FROM 2011 – 2015

In the previous chapter 3, the focus was on analysis of the first participant in the supply value chain – food and beverage sector, while in this chapter emphasize is on a second player in the value chain and that is the distribution sector. Distribution is becoming more and more important in the recent years. TOP 10 distribution companies classified by the revenue in 2015 have recorded increase of the revenue for almost 1,0 billion Kuna. In other words, increase of their revenue was 12,5% in 2015 compared with 2011. The positive trend of increasing distributors revenue is even more visible after 2013. The biggest Croatian distributor is Orbico<sup>14</sup>. In 2015 Orbico generated 2,8 billion Kuna of non-consolidated business revenue, which represents more than 30% of total revenue of TOP 10 distributors in Croatia. Unlike the producers, in the last 5 years, the distributors have had lower margins, generating around 12%.

11 http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-

14 http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-

HR&Mode=HR&App=HR&CompanyId=437707&CompanyDetailType=FinancialData&CompanyDetailSubType=FinancniPodatki

<sup>&</sup>lt;sup>12</sup> <u>http://www.indexmundi.com/commodities/?commodity=corn&months=60</u>

<sup>&</sup>lt;sup>13</sup> <u>http://narodne-novine.nn.hr/clanci/sluzbeni/2007\_06\_58\_1870.html</u>, G - Wholesale and retail trade; repair of motor vehicles and motorcycles, H - Transporting and storage, J - Information and communication

NKD - National Classification of Activities, 2007 (NKD 2007)

HR&Mode=HR&App=HR&CompanyId=467874&CompanyDetailType=FinancialData&CompanyDetailSubType=FinancialData&CompanyDetailSubType=FinancialData

Rank 2015	Company	2011	2012	2013	2014	2015
1	Orbico	6,7%	5,1%	6,1%	6,5%	6,5%
2	Atlantic trade	13,2%	9,1%	12,0%	12,1%	11,6%
3	Roto dinamic	17,8%	16,7%	16,6%	16,0%	15,4%
4	AWT international	15,0%	13,6%	13,6%	12,8%	12,0%
5	Alca Zagreb	17,8%	20,3%	23,3%	21,9%	21,8%
6	Ferrero	11,4%	12,3%	15,2%	6,0%	6,0%
7	Nestle Adriatic <sup>15</sup>	14,3%	14,4%	14,8%	12,2%	14,1%
8	Procter&Gamble	6,9%	10,5%	7,4%	7,7%	7,3%
9	Stridon Promet	11,3%	13,1%	14,1%	14,1%	14,1%
10	Stanić promet	23,8%	21,1%	22,3%	22,0%	25,7%
	Average TOP 10	12,4%	11,6%	12,5%	11,6%	11,5%

**Table 3.** Analysis of the approximate gross margin for TOP 10 distributors in food and beverage industry

Source: Lider 1000 the biggest by the total revenue in 2015, boniteti.hr, authors analysis

TOP 10 distribution companies classified by the revenue in 2015 have recorded slight decrease in gross margin<sup>16</sup> for around 1,0 pp in 2015 comparing with 2013. Few distributors are generating the increase in profitability, such as Orbico and Stanić<sup>17</sup>, while others have recorded a small decline in profitability. If comparing distribution sector with food and beverage industry, especially if comparing with production of non-alcoholic drinks, distribution sector is achieving lower gross margins. The main reason is the type of services they provide (purchasing, distribution and sales of goods to specific retail chain or to final consumer).

Rank	Company	2011	2012	2013	2014	2015
2015						
1	Orbico	1,5%	0,2%	1,4%	2,0%	2,7%
2	Atlantic trade	2,6%	-1,6%	0,4%	1,4%	1,3%
3	Roto dinamic	6,2%	5,1%	4,6%	6,3%	6,3%
4	AWT	5,3%	2,7%	3,6%	2,0%	1,9%
	international					
5	Alca Zagreb	4,6%	5,1%	5,6%	4,9%	5,1%
6	Ferrero	8,9%	8,5%	11,6%	2,9%	2,8%
7	Nestle Adriatic <sup>18</sup>	-7,2%	-6,8%	-5,2%	-8,2%	-5,0%

Table 4. Analysis of the approximate EBITDA margin of TOP 10 distributors

<sup>15</sup> Classified as NKD G46.36 Wholesale of sugar and chocolate and sugar confectionery in Croatia <sup>16</sup> Gross margin = (operating revenue-cogs-other external costs) / operating revenue

<sup>&</sup>lt;sup>17</sup> http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-

HR&Mode=HR&App=HR&CompanyId=462813&CompanyDetailType=FinancialData&CompanyDetailIsubType=FinancniPodatki

<sup>&</sup>lt;sup>18</sup> By revenue Nestle is 7<sup>th</sup> company with negative EBITDA margin through all the observed years (according to activity, Nestle is registrated as distributor in Croatia)

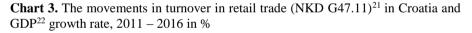
	Average TOP 10	2,8%	1,7%	2,5%	2,1%	2,7%
10	Stanić promet	3,8%	2,8%	2,6%	0,3%	3,5%
9	Stridon Promet	2,4%	3,4%	3,9%	3,8%	3,7%
8	Procter&Gamble	2,1%	4,9%	1,0%	3,2%	2,8%

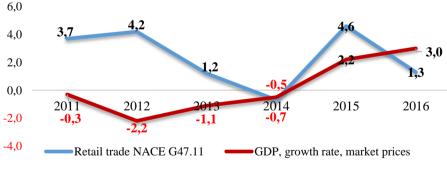
Source: Lider 1000 the biggest by the total revenue in 2015, boniteti.hr, authors analysis

When observing the EBITDA margin, the distributors recorded growth in 2015, comparing with 2013. The average EBITDA margin of TOP 10 distributors is around 2.5%. If comparing with food industry (about 9% in the food industry) the margins are noticeably lower in distribution sector. Distributors as the second players in the supply value chain, are achieving the lowest profitability of all participants. Nevertheless, distributors of beverages, such as Roto Dinamic<sup>19</sup> are generating the EBITDA margin at the same level as retailers (between 5-7%). On the other hand, if we put the focus on different indicator, such as, income per employee, then the distribution sector is the most efficient. The average income per employee in 2015 was 2.3 million Kuna, while at the same time the producers recorded 1.2 million Kuna of income per employee. The difference is almost 50%.

#### 7. SITUATION IN RETAIL SECTOR, NKD G47.11 AND NKD G47.19

The main characteristics of retail in Croatia are the high degree of market concentration and saturation. TOP 10 retailers present more than  $75\%^{20}$  of total retail trade in Croatian market.





Source: CBS (retail trade turnover) and GDP

<sup>&</sup>lt;sup>19</sup> <u>http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-HR&Mode=HR&App=HR&CompanyId=450178&CompanyDetailType=FinancialData&CompanyDetailSubType=FinanciABA&CompanyDeta&CompanyDeta&CompanyDeta&CompanyDeta&CompanyDe</u>

<sup>&</sup>lt;sup>20</sup> GFK -market trends monitor 2015 in Croatia

<sup>&</sup>lt;sup>21</sup> Retail trade, december 2011 – 2016, first releases, CSS (Sub-area: Distributive Trade and Other services)

<sup>22</sup> CBS, NUMBER: 12.1.1/2., NSO ISSN 1330-0350

The movements in retail trade in Croatia in observed period showed a positive trend. In the same observed time, the GDP measured at constant price recorded a negative trend. The type of trends in curves from above, where the red curve presents the GDP growth rate, while the blue curve presents the retail turnover are showing a divergence trend in observed period time. The retail turnover is constantly above GDP growth rate 2011 - 2016 which means that the retail sector is much more resistant than other sectors in economy. Gap between the curves in observed period was in favour of retail sector, especially in 2012 where the gap was at the highest level and difference between GDP growth rate and retail growth rate was 6.4%. Therefore, in the observed period the retail sector passed through expansion, while the Croatian economy has passed through the contraction period and recorded negative growth rate. The chart above, presents strong negotiation skills of retail sector through the recession period, where the overall economy faced the downturn. All components of GDP decreased while the retail sector recorded growth in observed period. Therefore, some of the participants in supply value chain had amortized imperfections in their business (e.g. decrease in margins) in the observed period.

# 8. BUSINESS ANALYSIS OF TOP 10 COMPANIES IN THE RETAIL TRADE SECTOR (NKD G47.11 AND NKD G47.19)

The last, but not the least player in the supply value chain is the retail sector. In the last 5 years, the retail sector is experiencing an exceptionally high level of concentration. The first TOP 10 retailers (retail chains<sup>23</sup>) account for more than 75% of the total retail value in Croatia. High retail concentration is the main characteristic of developed countries.

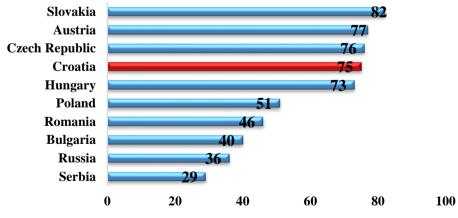


Chart 4. Share of TOP 10 retailers in total retail sector in 2015 in %

Source: GFK retail monitor 2016/2015 June 2016

<sup>&</sup>lt;sup>23</sup> Metro is excluded – in the same time he has the role of a wholesaler and retailer (registered under NKD G46.90)

From appointed countries, in the TOP 10 retailers, Romania, Bulgaria, Russia and Serbia have the lowest share of top 10 retailers in total retail sector (lower than 50%). The consolidation of retail sector in Croatia, started in 2008, when the share was reaching 60%<sup>24</sup>. Still, a real beginning of the market consolidation started with entrance of the biggest international players in Croatian market, Lidl and Kaufland (Schwarz Group<sup>25</sup>). Today, Schwarz group exceeds 20% of market share.

Rank 2015	Company	2011	2012	2013	2014	2015
1	Konzum	26,6%	25,9%	25,9%	26,1%	25,8%
2	Plodine	25,1%	24,9%	25,7%	25,1%	23,9%
3	Lidl	19,9%	20,5%	23,3%	25,6%	26,6%
4	Kaufland	22,5%	22,9%	23,4%	24,4%	25,7%
5	Spar Hrvatska	25,5%	25,6%	25,9%	26,5%	25,8%
6	Tommy	22,6%	23,0%	23,8%	24,4%	25,0%
7	Billa	19,0%	17,4%	21,2%	24,6%	23,7%
8	Studenac	23,7%	24,1%	24,5%	25,0%	26,0%
9	KTC	18,7%	18,8%	19,8%	19,9%	19,6%
10	Metss	23,1%	22,7%	22,5%	23,0%	23,3%
	Average TOP 10	24,4%	24,1%	24,7%	25,3%	25,2%

Table 5. Analysis of the approximate gross margin<sup>26</sup> TOP 10 retailers

Source: boniteti.hr, authors analysis

From TOP 10 mentioned retailers according to NKD G47.11 and NKD G47.19, Lidl<sup>27</sup> is achieving the largest gross margin.

Rank 2015	Company	2011	2012	2013	2014	2015
1	Konzum	6,9%	6,2%	6,7%	6,9%	7,1%
2	Plodine	10,4%	9,7%	9,3%	8,9%	7,9%
3	Lidl	1,1%	1,8%	4,4%	5,8%	8,0%
4	Kaufland	2,2%	2,2%	2,2%	2,4%	0,1%
5	Spar Hrvatska	-0,1%	0,9%	0,6%	1,1%	-0,6%
6	Tommy	6,9%	6,5%	8,0%	7,7%	8,7%
7	Billa	-4,6%	-7,6%	-2,6%	-0,7%	-1,4%
8	Studenac	6,0%	5,6%	5,2%	5,1%	6,3%
9	KTC	5,5%	5,3%	5,9%	6,2%	5,3%

Table 6. Analysis of the approximate EBITDA margin of TOP 10 retailers

<sup>&</sup>lt;sup>24</sup> GFK – GFK retail monitor 2016/2015 June 2016

<sup>&</sup>lt;sup>25</sup> German retail chain with annual revenue more than 85.6 bn EUR, source: <u>www.igd.com</u>

<sup>&</sup>lt;sup>26</sup> Gross margin = (operating revenue-cogs) / operating revenue

<sup>&</sup>lt;sup>27</sup> http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-

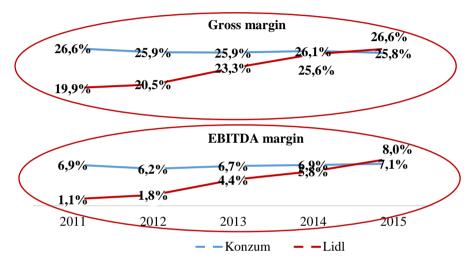
HR&Mode=HR&App=HR&CompanyId=471779&CompanyDetailType=FinancialData&CompanyDetailSubType=FinancialData&CompanyDetailSubType=FinancialData

10	Metss	5,1%	3,8%	3,0%	2,8%	4,0%
	Average TOP 10	5,3%	4,8%	5,4%	5,7%	5,7%

Source: boniteti.hr, authors analysis

When analysing a profitability on the level of EBITDA, Tommy represents the most profitable retailer among the TOP 10.

Chart 5. Profitability analysis of Lidl and Konzum<sup>28</sup> from 2011 to 2015



Source: boniteti.hr (Konzum and Lidl reports), authors analysis

After the liberalization of Croatian market in July 2013, discounter Lidl made a strong expansion in Croatia. The gross profit margin has increased from 19.9% in 2011 to 26.6% in 2015, what represents overall growth of 6.7pp, Meanwhile, Konzum, the biggest retail chain recorded a slight decrease in profitability of -0.8pp in the same observed period. When analysing the EBITDA margins, the differences are even bigger. Lidl closed 2011 with result of 1.1% EBITDA margin, and Konzum had EBITDA margin around 6.9%, while in 2015 Lidl increased its EBITDA margin to 8.0%.

Chart 5 shows that the movement of profitability significantly accelerated after 2013. The high level of Lidl's profitability and profitability of other retailers had an impact on other participants in supply value chain. Wide availability of cheap goods from abroad, forced domestic producers to be more competitive with prices, thus, they declined their margins. This was pointed in the beginning of this paper.

<sup>&</sup>lt;sup>28</sup> http://www.boniteti.hr/BoniteteCE/Pages/Company.aspx?Lang=hr-

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The local food sector wasn't ready to answer on exogenous shocks from foreign import from international retailers, therefore profitability in whole value chain was significantly disrupted. The external trade balance is also affected.

In the supply value chain, the profitability has rapidly decreased. The "Paret's" effect occurred.

From the last few years, Croatian market is facing a strong pressure on producers' prices from mostly retailers and from some distributors.

In the last several years, the expansionary monetary policy did not push the price in positive level on consumer side. Inefficiency of monetary policy in terms of increasing prices (CPI) led to double deflation effect (CPI, PPI).

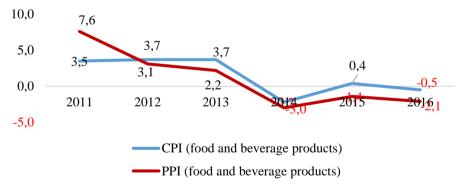
**Table 7.** Inflation trends in consumer and producer prices (CPI and PPI) 2011 - 2016, in %

	2011	2012	2013	2014	2015	2016
CPI (food and beverage products)	3,5	3,7	3,7	-2,2	0,4	-0,5
PPI (food and beverage products)	7,6	3,1	2,2	-3,0	-1,4	-2,1
GAP (CPI-PPI)	-4,1	0,6	1,5	0,8	1,8	1,6

Source: CBS, authors analyses

Followed is graphical display.

**Chart 6.** Inflation trends in consumer and producer prices (CPI and PPI) 2011 - 2016 in %



Source: CBS, authors analyses

After 2011, Croatian economy was faced with negative gap between inflations (consumer price index and producer price index). In the observed period, the retailers had more deflated prices than producers and other players in supply value chain. Because of all mentioned factors, retailers amortized a big amount of margin caused by producers and distributors imperfections until the period 2011 where the gap between retailers and producers was on the producer side (4,1% difference). In the next period (after 2011), the trend of inflations was turned around, where producers

in supply value chain were faced with big pressure from the retailers and foreign competitors. Because of this trend, producers cut off part of their margins, in order to maintain competitiveness on the market by reducing their own profits (chapter 2). The significant pressure on prices competitiveness came after 2013 when Croatia joined EU28. In this period, producers were faced with imported inflation and they were forced from the retailer side to reduce their price to maintain a competitive advantage. Moreover, the deflation on the consumer side (CPI) began in 2014, but comparing with the deflation on the producer side (PPI), the gap between this two deflations remained positive in favour of retail chain +1,6pp. Although, the TOP 10 retailers are employing more than 30,000 people and they present the biggest employer in observed value chain, compared to the other players (TOP 10 distributors 13,000 employees, TOP 10 producers 4,000 employees) they are still the one with the lowest average net salary per person (4,387 Kuna in 2015).

#### 9. CONCLUSION

The profitability of the participants in the supply value chain from manufacturers through distributors and end customers is extremely complex. It depends on the type of production, distribution methods and bargaining power of retailers. Entrance of foreign retail chains, which was even more significant after the liberalization of the market, together with Croatia joining the EU28, was followed with a strong pressure on the price competitiveness among all participants of the supply value chain. Cheap products from abroad had the effect of importing deflation in Croatia. Afterwards, the import inflation caused deflation in the domestic market, where domestic producers were the one most negatively affected by that. Other participants of the value chain, retailers and distributors were mostly shifting their "inefficiencies" to the manufacturing sector (food and beverage production). Moreover, in 2013 Croatia was faced with the challenge of double deflation on the manufacturing side and on the consumer side (Chart 6). Despite of expansionary monetary policy and the increase in personal consumption, manufacturing sector needed to gave up part of their margins to maintain a competitive position in the market. Even though the deflation was partially present on the consumer side, on the manufacturing side was significantly higher. In the Food Industry (NKD C10 and NKD C11), the EBITDA margin is almost the same as the EBITDA margin of the retail chains, which is a long-term problem and can cause a disruption of profitability in the supply chain. The world practice is that average producer has at least 3% higher EBITDA margin than a retailer (see references), and over 5% higher EBITDA margin when comparing with distributor. If the trend of putting the pressure on domestic producers directly or indirectly by retailers continuous, Croatian economy will be faced with tremendous negative consequences. Altogether, the competitiveness of domestic food production will be distorted. In 2016 the profitability of food producers in Croatia is showing a negative trend, while the profitability of retailers is increasing. Retail sector was growing in 2016 for 1,3% (NKD G47.11, Chart 3) in comparison with 2015. Therefore, the overall stability of the participants in supply value chain is for sure going to be distorted. The most affected participants will be producers, followed by distributors whose business is becoming more risky due to the market complexity. The expectations are that the relationship between the participants in supply value chain will be negatively changed, namely affecting producers. The competition in supply value chain will be more aggressive in the following period, due to the negative trend of consumers spending in Croatia. The results of all mentioned facts are causing a spiral effect on Croatian economy. Croatian economy is also facing with deficit of workforce followed by decrease in personal consumption, negative demographic balance and finally with a drop of profitability in the supply value chain. To summarise, it is expected that the retail sector will continue to grow, while distributers will most probably face with some difficulties. Their survival will depend on their negotiation skills and their flexibility to adapt to fast moving market conditions. The producers will be the ones most negatively affected, which was mentioned in the hypothesis in this paper.

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http://www.boniteti.hr/CreditReportsPrimus/Kontrole/Rezultati.aspx?App=HR&Mo de=HR&Lang=hr-HR&SearchMode=A&SearchName=podravka Profitability of participants in supply value chain in Croatia Darko Karić. Duro Horvat

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## Abbreviations for NKD or NACE:

http://narodne-novine.nn.hr/clanci/sluzbeni/2007\_06\_58\_1870.html, NKD or NACE - National Classification of Activities, Version 2007 or http://ec.europa.eu/competition/mergers/cases/index/nace\_all.html

NKD C10 - Manufacture of food products

NKD C11 - Manufacture of beverages

NKD G46.90 - Non-specialised wholesale trade

NKD G46.36 - Wholesale of sugar and chocolate and sugar confectionery

NKD G47.11 - Retail sale in non-specialised stores with food, beverages and tobacco predominating

NKD G47.19 - Other non-specialised stores

## BRAND IMPLEMENTATION ON THE WEB IN MARKETING CHANNELS

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#### Abstract

The development of a global electronic market with the concept of branding on the Web raises the level of the image of the industry trade organizations in marketing channels. Creating and maintaining brands on the Web requires defining the key elements of branding. Effectiveness and efficiency of brands on the Web is based on the identity of the strength and vision in dealing with customers. Key elements of the brand as a great importance for customers are: differentiation, relevance and perceived value. If you establish a brand diversity in relation to other competing brands, and achieve the level of acceptance by the potential buyer, also inspires and provides a perceived value. Implementation of the policy for brands perceived value on the Web generate effects in improving the image of customer loyalty, increase trade volume and profitability. The power of creating and maintaining brands on the Web is an indication of success, or the efficiency and effectiveness of the assortment offered by a trading enterprise in the global electronic market.

**Key words:** global market, Web brands, differentiation, loyalty, relevance, perceived value

## **1. INTRODUCTION**

Branding in the online environment is gaining very important role in the conditions of globalization and internationalization. By integrating branding and marketing through a variety of channels development of the brand position in the global market is inevitable. Branding enhances customer confidence in the direction of satisfaction with purchase and efficiency of search on the electronic market. Unique brands use their keywords as search tools. Web sites are globally available, and

Internet technologies contribute to branding globally. Global brands identify different values in the national context. But also, brand experience can be different for each individual customer. With the "one to one" interaction with customers it is possible to generate a different experience for the brand and lead to the creation of a series of brands for different groups. Web sites convey the brand message through their design and functionality. A systematic approach to developing brands in the online market requires answers to the following questions:

- What are the dimensions of powerful Web brands in marketing channels?

- What are the basic components that influence the differences in online and offline branding?

- What impact does the satisfaction with off-line brand have on consumer loyalty to on-line brand?

Managers need to identify the elements of consistency and elements of differentiation between the offline and online branding. Brand value should provide the answer to users who search for information about products and services. Online branding encourages and increases the efficiency of communication in the digital environment. Preliminary results of the research were shown in this paper, as a part of wider research on implementation of brand in electronic environment.

# 2. THE GROWTH OF GLOBAL ELECTRONIC COMMERCE IN MARKETING CHANNELS

Trade revolution becomes a driving force and a factor of economic development and globalization of markets. Global retail concentration becomes more intense and encourages competition for market position. "The transformation of classical into multichannel retailers involves a lot of opportunities and challenges in integrating the different channels (Trenz, 2015, p. 22)."

In the increasingly severe competition retailers are expanding into new markets, creating new multi-channel strategies, increasing the technological base of operation, improving service quality, technological innovations, new retail formats and so on, and of great importance is become recognisable by development of the brand and its implementations in electronic environment. "In a competitive environment of B2C businesses, companies must leverage their resources to gain competitive advantage; the development of brand equity is one such advantage (Kim, Sharma & Setzekorn, 2002, p. 130)".

The growth of global online business, thanks to the ubiquity of computers and mobile phones with Internet access, is changing position of e-commerce in marketing channels."E-commerce, in contrast, is characterized by its ubiquity: it is available just about everywhere, at all times (Laudon & Traver, 2016, p. 53)." Ubiquity creates the possibility of Internet access which affects the new opportunities in online business. Increasing global online business is present, especially in less developed Asian countries, which have a rapid growth of the economy and a growing number of users of mobile phones and tablets with Internet access. Overview of Internet users in the world can be seen from the following table 1.

"E-commerce technology permits commercial transactions to cross cultural, regional and national boundaries far more conveniently and cost-effectively than is true in traditional commerce (Laudon & Traver, 2016, p. p. 54)." The impact of globalization on the electronic market can be seen in indicators of Internet users and penetration rate of the population.

Regions of the world	Population (Estimated 2017)	Populatio n % of world	Internet users in the world 31 March 2017	Penetration rate (% population)	Growth 2000- 2017	Users % table
Africa	1.246.504.865	16,6 %	345.676.501	27,7 %	7.557,2 %	9,3 %
Asia	4.148.177.672	55,2 %	1.873.856.654	45,2 %	1.539,4 %	50,2 %
Europe	822.710.362	10,9 %	636.971.824	77,4 %	506,1 %	17,1 %
Lat. America/ Caribbean	647.604.645	8,6 %	385.919.382	59,6 %	2.035,8 %	10,3 %
Middle East	250.327.574	3,3 %	141.931.765	56,7 %	4.220,9 %	3,8 %
North America	363.224.006	4,8 %	320.068.243	88,1 %	196,1 %	8,6 %
Oceania/ Australia	40.479.846	0,5 %	27.549.054	68,1 %	261,5 %	0,7 %
TOTAL	7.519.028.970	100,0 %	3.731.973.423	49,6 %	933,8 %	100,0 %

Table 1. Internet users in the world and the population statistics in 2017

Source: http://www.internetworldstats.com/stats.htm 28.03.2017

The first indicator indicates a high share of the population of Asia, which has a high percentage of population in the world with 55.2% and percentage of Internet users with 50.2%, in contrast to other regions of the world. Asia is followed by Europe in number of Internet users whose share amounted to 17.1%, followed by Latin America / Caribbean with 10.3%, while other regions of the world have less than 10% of Internet users.

Globalization boosts retail competition and concentration, changes the relationship between the participants in marketing channels and strengthens the position of retailers. The growing internationalization of retail activity causes changes in the competitive structure of the domestic market and the market in which foreign companies are coming (Lovreta, et al., 2013, p. 567). Internationalization and multichannel strategies have a comprehensive impact on the growth and development of business retailers. Global multichannel retailers develop specific strategies that are based on the new information technologies. The effects of the internationalization of multichannel retailers are linked to the processes of modernization of markets and trade (Končar & Leković, 2015, p. 364). As seen in Table 2, retailers from individual countries have a high share of e-commerce in total retail revenue.

Global level of e-commerce can be seen by analyzing the top ten electronic retailers in individual countries. Amazon.com Inc has expression of international e-commerce strategy with its business on every continent. These retailers have their

electronic sales in the domestic market, and have successfully applied electronic sales on other markets by successfully implementation of brand on the web.

Rank	Company	Country	Electronic retailing (mil. \$)	Electronic retailing as % of total retail sales	Electronic retailing growth of rate
1	Amazon.com Inc.	USA	70.080	100,0 %	15,1 %
2	Apple Inc.	USA	20.600	49,0 %	12,6 %
3	JD.com Inc	China	17.672	100,0 %	62,0 %
4	Wal-Mart Stores Inc	USA	12.200	2,5 %	22,0 %
5	Otto (Gm bh & Co KG)	Germany	8.397	65,4 %	5,6 %
6	Tesco PLC	United Kingdom	6.504	6,5 %	20,0 %
7	Macy's Inc.	USA	5.400	19,2 %	30,1 %
8	Liberty Interactive Corporation	USA	5.198	49,5 %	6,4 %
9	Casino Guishard- Perrachon S.A.	France	4.606	7,1 %	20,1 %
10	Suning Commerce Group Co., Ltd.	China	4.199	23,7 %	17,8 %

 Table 2. The biggest 10 electronic retailers

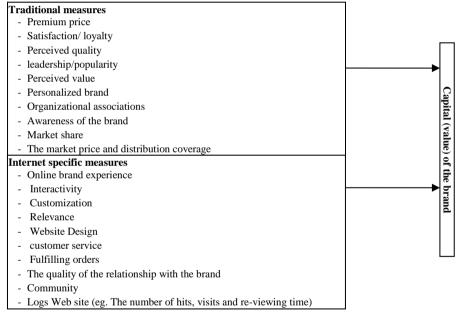
Source: Deloitte, 2016.

Table 2 indicates the number of different rates of growth of e-commerce retailers in a multichannel strategy in the global market. The development of the multichannel retail strategy is directed towards the implementation of technology in the development of electronic retailing. The largest e-retailers are from the US and China, as well as from Western European countries, primarily Germany, Great Britain and France. Those electronic retailers have developed their image and brand name on global level. "Creating a customer experience that is synonymous with a particular (website) brand is becoming increasingly recognised as a vital driver of e-performance (Ha & Perks, 2005, p. 438)".

The full effect of electronic retailing for top ten e-retailers is seen in the total income from sales and other performance of retailers in the internationalization of business when their integrated multichannel strategy develop. Electronic retailers using the multichannel strategy define the role of different marketing channels in certain markets and thereby create a distinctive position in relation to competitors of the global market.

# 3. CREATING AND MAINTAINING BRANDS ON THE WEB IN THE GLOBAL MARKET

Web communications in interaction with customers directly influence the concept of creating and maintaining electronic branding. E-commerce has a strong influence on the structure of the online brand. Technological innovations affect the restructuring of the brand. Electronic Customer Relationship Management allows personalized interactive contact with the primary goal of generating a multi-brand strategy. "Greater interactivity promotes greater brand learning through better information brand sites and that boost levels of interactivity can fulfill online brand building missions more effectively (Dou & Krishnamurthy, 2007, p. 204)". Brand awareness and confidence plays a key role in the online market. In the global market Web has become an integral part of modern brand image.

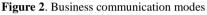


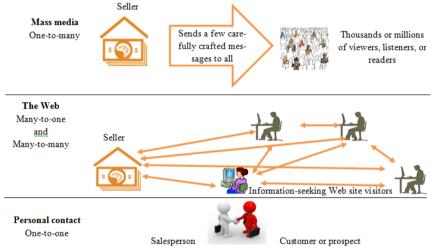
Source: Christodoulides & Chernatory, 2004, p. 170

Brand image reliably contributes by creating value for the customer due to the reduction of risks and costs for search, creating favourable attributes of perception. Brands have traditionally been understood as value identifiers. Online experience includes all points of interaction between customers and the brand in the virtual space. WWW brand represents digitally built brand that is focused on the customer in order to monitor all aspects of the brand interactivity with consumers. Online space required customization preferences at the individual level in order to tailor the content of Web sites according to the requirements of each individual customer. Web design, through functional parameters, should provide incentives and customer satisfaction.

During the interaction with the brand a brand experience that is related to the perception of consumers towards design and brand identity is created and formed. Brand experience leaves a lasting impression on consumers, with the aim of building and improving relationships with consumers of the brand. Brand Internet communication with customers creates a new approach to experience the brand through various touch points in the search, evaluation, acquisition and consumption of products.

Web presence in the global electronic marketplace helps identifying retailers and their communication with visitors who are customers or potential customers. "One-to-one marketing is marketing that treats each customer in a unique way (Turban, et al., 2012, p.436)." Personal contacts and mass media as well as two general ways of communication contribute to the transmission of information. Position of the Web as a medium for contact with the customer is located between major markets addressed with mass media and focused addressed markets with the sale of personal contact and promotional techniques.





Source: Schneider, 2017, p. 148

According to the presented illustration, it is evident that the communication is going from one to many potential customers - communication model is one to many. In this model the promotional process of the mass media, retailer has an active position, while the buyer is passive. Building confidence and maintaining the relationship between the elements contribute to the development of models of personal contact - one to one. The flexibility of the model of personal contact one on one leads to communication over the Web, with the aim of obtaining information on the Web.

Web brand market share records advantage, thanks to the Internet, which has a much higher degree of interactivity, compared to other communication media (Končar, 2015, p. 299). The retailer and the consumer actively participate in the

exchange of information. Web allows many communication channels with a communication model many-to-one, or even many-to-many, which to a large extent depend on the required information on the Web.

Branding programs contribute to the reputation of the brand name. "The key elements of a brand are differentiation, relevance and perceived value (Schneider, 2017, p. 191)." Product differentiation is the first and leading form of creating a product or service brand, with a view to their distinction from other competitive products and services on the market. Other branding element is related to the relevance which includes the efficiency of the product or service for potential consumers. The third component of branding related to cognitive value is a key element in creating a brand that has a value. If you establish a brand difference - differentiation from other competing brands, become relevant and inspire cognitive value to potential customer purchasing of the product has to follow. Brands become successful when you reach a level of understanding for and acceptance by customers.

## 4. EMPIRICAL ANALYSIS OF ONLINE CONSUMER BRAND LOYALTY IN MARKETING CHANNELS

Orientation towards internationalization, the globalization of business and achieving competitive advantage is achieved thanks to multi-channelling. One of the major trends in creating and maintaining Web brands on the global market are the high importance of online consumer brand loyalty. Preliminary research results, as u part of larger research about importance of efficient brand implementation in all marketing channels, are shown in this article to present consumers satisfaction with a brand and its characteristics. The following was proved in accordance to the goal of the research we conducted:

H0: Satisfaction with the characteristics of the brand has a positive effect on online brand loyalty.

Brand consumer experience has a multidimensional structure with dimensions that relate to visual identity, emotional experience and functionality. Visual experience is the dimensions related to logo, name, colour, symbol, and design of the retailer. Visual identity of the retailer is represented with the combination of graphic elements and symbols. Visual components of the retail brand influence the creation of the offer, which is completely different from other brands. These dimensions are focused on customer satisfaction with the brand that has a positive impact on brand loyalty online. The next hypothesis of the research is defined according to that:

H1: Satisfaction with visual identity of brand has a positive effect on online brand loyalty.

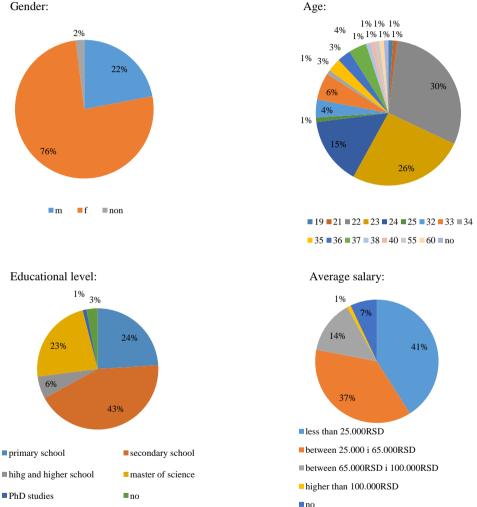
The emotional experience of consumers is derived from the relationship related to the feelings and emotions of consumers connected with the brand. It may include positive and negative emotions that influence consumer loyalty to the brand online. This brings the definition of the second hypothesis of the research:

H2: Satisfaction with the emotional experience of the brand has a positive effect on online brand loyalty.

Functionality is related to the creative use of a single brand offers. It is the outcome of interactivity of the brand, but as component functionality it contributes to online transactions. Third hypothesis of the research is defined in accordance with that:

H3: Satisfaction with the functionality of the brand affects the loyalty of online brand positively.

**Figure 3**. Characteristics of the sample Gender:



Source: Authors' calculation

100 respondents have participated in the research on the identification of the brand and brand recognition on the Web. Characteristics of respondents are shown in

figure 3. According to the gender structure, women are more represented with 76% of the respondents, in the age structure respondents that are mostly represented are those aged 22 to 24 with 81%. In terms of educational structure most of the respondents have secondary education (43%) and basic education (24%), followed by master's degree (23%). Most of the respondents 78% have income levels up to 65,000 dinars (78%).

Respondents evaluated satisfaction with visual identity, emotional experience, and functionality of online brands that also have an offline presence. Satisfaction with visual identity is rated in terms of the impression that the identity has on the senses and on the basis of the slogan of the brand. Assessment of the emotional experience of satisfaction is monitored in terms of positive / negative feelings, feelings of "happiness" in transactions with the brand and the sense of "relief". Satisfaction of functionality with online brand is estimated to ease online transactions with the online brand.

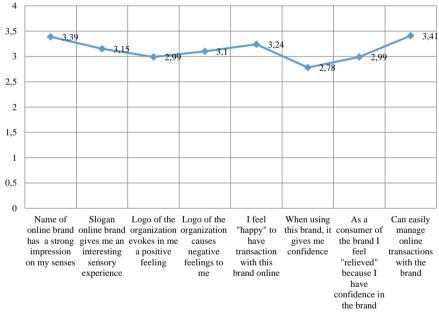


Figure 4. Evaluation of the online brand

#### Source: Authors' calculation

According to the survey the top rating in customer satisfaction with online brand respondents provides ease of online transactions with the control of a brand (3.41) and the impression of the brand names that leaves to their senses (3.39), while the lowest estimate has feeling of "happiness" in transactions with online brand (3.24). The analysis of positive and negative feelings that the brand has on respondents indicated that a negative sense has a greater impact on satisfaction or it increases dissatisfaction with the brand.

## Figure 5. Evaluation of the characteristics of the brand



Source: Authors' calculation

Rating characteristics of online brand indicates that most respondents rely on the functionality of the brand (H3: 3.41), a little less on the visual identity (H1: 3.27), while they are the least reliant on emotional experience (H2: 3.02). Overall satisfaction (H0: 3.23) is closest to the visual identity of the brand and the emotional online experience that respondents have with the online brand with functionality approaching overall satisfaction with the online brand in the slightest degree.

## **5. CONCLUSION**

The global electronic market concept of branding on the Web is becoming more intense and encourages competition for market position. In the increasingly severe competition, efficiency and effectiveness of brands is based on new multi-channel strategies, as well as the new strength and vision in dealing with customers. One of the most important global trends of internationalization is a high correlation between the internationalization of retail and electronic retail existence. Identifying the brand and brand recognition on the Web is rated by satisfaction with visual identity, emotional experience and functionality of online brands. Positive and negative feelings that online brand has on respondents indicate that a negative sense has a greater impact on satisfaction or increases dissatisfaction with the brand. Preliminary research results top rating in customer satisfaction with online brand respondents provide ease of online transactions with the control of a brand and the impression of the brand names that leaves to their senses, while the lowest estimate has feeling of "happiness" in transactions with online brand. Rating characteristics of online brand indicates that most respondents rely on the functionality of the brand, while they are the least reliant on emotional experience.

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## ROOT CAUSE ANALYSIS METHODS AS A TOOL OF EFFECTIVE CHANGE

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#### Abstract

Companies which operate in reality of the free market economy encounter problems. These problems may come from internal circumstances, such as not achieving planned KPI results, or external, like acquiring necessary resources for fulfilling their liabilities to customers. In order to solve the problem the most important issue is to reach the sources of its formation and eliminate the root causes. Determining those reasons unskilfully can cause delay in solving the problem or give improper solution, which generates additional loss of, for example, time, human resources, customer confidence or cash. Based on the survey conducted in a group of 50 managers, senior and middle management level, here is presented assessment of effectives of these methods. Each respondent was asked to select which of these methods they use, and rated them on a scale from 1 to 5 the effectiveness of the method. In the survey 1 means ineffective method, and 5 perfectly identifies the root cause. Despite the fact that, taking into account the results of the survey, there are many methods to determine the root cause, the most valued methods are: 8D report, "5 why's?" and Ishikawa's diagram. Respondents also noted that often a combination of two methods is used.

**Key words:** Effective change, root cause analysis (RCA) methods, managing the change, survey results RCA, 8D report.

## **1. INTRODUCTION**

When encountering a problem, it is impossible to solve it efficiently with no access to its root cause. The root cause of a given unfavourable state is considered to be its most harmful feature, condition, behaviour, action and/or idleness. They are all revealed by at least one essential state feature that was a result of more important or more basic features, conditions, behaviours, actions and/or idleness. In the reference literature there are a number of methods which might be applied to analyse the causes. The presented methods are different from each other in terms of the reasoning method. A deductive reasoning is applied in the Ishikawa diagram, Conflict Resolution Diagram, Why-Why diagram (5 Why?) but induction is applicable to the Current Reality Tree, Why-Why diagram, case study, ABCD method, the Six Thinking Hats technique and the scenario method. The brainstorming and 8D's methods are characterised by both the inductive and deductive reasoning.

A basic purpose of this paper is answer the questions "which method managers of Polish enterprises are currently using and how they assess its efficiency?" and "how one should implement root causes analysis methods in order to achieve the intended goal?".

#### 2. SELECTED ROOT CAUSE ANALYSIS METHODS

The authors selected 10 key RCA methods described in the literature based on preliminary direct interviews with high- and medium-level managers. The performed analysis does not cover all the RCA methods that are available in the reference literature. As part of the above, the FMEA (Failure Mode and Effect Analysis) method was intentionally omitted but was mentioned by the investigated managers. This is related to the fact that the mere method determines the risk of occurring potential problems but it does not aim at determining them.

By contrast, RCA is one of the most useful themes being used by practitioners around the globe for quite a long time in industrial problem solving on quality and productivity, plant safety, accidents, etc. (Kalantri & Chandrawat, 2013, p. 62-67) The theme is continually being developed by the researcher sand practitioners (Bhattacharya, J., 2014 p. 12-20). It can be bifurcated into two broad categories - identification of the potential causes and validation to root cause. Doggett (Doggett, A.M., 2005, p. 34-45) provides a framework formally sing the performance of the three RCA tools - cause-and-effect diagram, interrelationship diagram and reality tree. In order to validate the causes, it needs to be supported by evidence (Eckert, C & Huges, C., 2008, p. 38-43). A Bayesian network has been proposed to identify the root causes in analysing the non-random patterns of SPC charts (Alaeddini, A & Dogan, I., 2011, p. 11230-11243). It has been shown by (Huertas-Quintero et al., 2011, p. 38-46) how RCA can help to implement design for quality if the relationship between cause and effect is known.

#### 2.1. Case Study

A case is a written description of a problem or problems and their analysis. Most cases include the information on the organisation history, its internal actions and environment. The case study might present various problems related to competitors' industry and conditions, products and markets, technological base, managers' personality, organisational structure, financial statements and quantitative data from the domain of production, accounts, marketing and/or staff. A case study of an enterprise makes it possible to get relocated to a realistic situation. The situation makes it feasible to practice the abilities to make managerial decisions. The described

cases are never complete as it would be required by their completeness to give numerous details which is impossible on several description pages. Nevertheless, the information insufficiency is also typical of the real world. In the enterprise it is not always feasible to postpone the decision-making process until the satisfactory quality and available information quantity are obtained. The latter situation does not often take place at all and the decisions need to be made. In this case it is required to make certain assumptions related to the unknown factors or to neglect them. The case study method might be helpful in getting ready for such a situation. It is necessary to realise that a manager should make the best potential decisions in every condition. Furthermore, a basic benefit from applying the cases comes from the mere process of their analysis and not necessarily from the fact that the only right answer discovery has been found.

## 2.2. Brainstorming

This method makes it possible to express ideas that would not be normally revealed for fear for being suspected of nor seriousness or competency. The method essence is to search for ideas, concepts, solutions and information in order to achieve the intended state i.e. to collect as many ideas as possible and to select the most beneficial one out of them in the possibly shortest period of time.

Therefore, the brainstorm aims at:

- forming the wealth of ideas about the considered problem which leads to achieving the set goal
- improving the ability to cooperate in a team which facilitates the formation of creative atmosphere and encouraging enthusiasm.

The team should consist of approximately 12 people. 1/3 of these people should be laymen. In the team there should not be people in superior-subordinate relationships. The team members intelligence level and communications skills should be ensured to be identical. A session should not last longer than an hour, a creative session is usually divided into several (e.g. 3) stages separated by breaks. In the second session there are 3 participants who are not excessively conservative and know the enterprise strategy and industry potential. The problem should be presented in such a way that it will get criticised. The list with ideas should be returned to the participants in order to be completed. During the second session the ideas are divided into the hot ones (to be applied within a week), the ones dependent on additional research and analyses (1 month) and the useless ones (over 6 months). The results should be announced.

## 2.3. "Why-Why diagram" (5 Why?)

The why-and diagram is a tree-type diagram and its basis is the assumption that each consecutive statement is specified by asking the question "why". The diagram is used to assess the network of problem causes and the relations between the problems. The "Why-Why" diagram implementation results in the possibility to find problem sources with their graphic representation and to develop short- and long-term solutions to the investigated problems. The "Why-why" diagram variation is a problem analysis by the "5 Why's" method and relies on asking the "why" question 5 times as indicated by its own name. The method objective is to diagnose the "fundamental cause". In Taiichi Ohno's view "it is necessary by the real problem solution to find a fundamental cause, not only its root. The fundamental cause is hidden deeper than the root". For this reason it is justified to ask a question about why a given problem occurred. This makes it possible to indicate the primal malfunctioning with a number of further consequences. As presented, the "5 Why's" method is applied to analyse a 7-stage "practical problem-solving" process.

The "5 Why's" method is merely a constituent part of the tool for identifying and solving problems. As it might be observed, a key solution aspect is to identify the fundamental cause. Due to that it is feasible to take effective preventive actions. The "5 Why's method" belongs to a group of methods to identify fundamental causes.

#### 2.4. Ishikawa Diagram

Another name for the Ishikawa diagram is the "fishbone diagram" or "herringbone diagram" The Ishikawa diagram is an image of mutual correlations between process influencing factors and effects caused by them. The work on developing the chart takes place among numerous employees in the form of brainstorming. Each participant has an opportunity to speak freely as each remark is a step towards the intended objective fulfillment (Bozarth, C. & Handfield, R.B., 2012, p.126).

The diagram formation process relies on specifying the process result that will give rise to making further considerations. The mentioned process result is written on right side of the main horizontal axis. (Muhlemann, A.P., et al., 1997, p. 311). The next work stage relies on indicating main (major) causes. The application of the 5M cause classification appears to be helpful in this case (Bozarth C,. & Handfield, R.B., 2012, p.126) - Man or Manpower, Method, Machines, Material and Measurement.

Other sources (Muhlemann, A.P., et al., 1997, p. 311) also mention another 6<sup>th</sup> M as "environment and management". Nevertheless, the above described groups of causes are not required to form the Ishikawa diagram. One might specify one's own essential groups every time an individual problem is considered. Such determined main factors are put on the branching directly connecting the main horizontal axis.

#### 2.5. Conflict Resolution Diagram

A conflict resolution diagram is another thinking process used in the Theory of Constraints. The diagram is used to analyse the reasons for forming a system limitation and the attempts to solve it by eliminating a preliminary conflict between the previously chosen assumptions. The Conflict Resolution Diagram structure is very simple. To fulfil the objective at least two situations (needed to achieve the objective – Needs) must occur. Nevertheless, it is necessary to take appropriate actions to make the situations be possible to occur. It might turn out that one cannot perform the actions as they oppose to each other and their simultaneous performance might create

a conflict. Such a conflict might be exemplified by: Prerequisite 1 - increase in investment expenditure, Prerequisite 2 - decrease in the enterprise expenditure.

The Conflict Resolution Diagram is a frequently used problem identification and solving tool. Its popularity is mainly implied by its application simplicity and transparency. This causes that the diagram might be executed in numerous groups by means of the brainstorming method. The tool efficiency might be shown by its application by such recognised authors as Mabin, Davies (Mabin, V.J. & Davies, J., 2003, p. 661–680, p. 670) and Chou, Lu i Tang (Chou, Y.C., et al., 2012, p. 4690).

## 2.6. Current Reality Tree

The Current Reality Tree comes from the Theory of Constraints. In the enterprise activity improvement the Theory of Constraints is focused on the enterprise internal process and system constraints. A constraint is a resource which makes it infeasible to fulfil the system design objective at a better level (Simatupang, T.M., et al., 2004, p. 58). The enterprise functioning improvement might occur at 3 levels. There are processes in the entire organisation and their correlations (Gupta, M.C. & Boyd L.H., 2008, p. 997) at the highest level. There are 5 basic organisation improvement steps according to TOC presented below (Goldratt, 2005):

- 1. Identify a constraint in the system
- 2. Define how to use the constraint in the system
- 3. Subordinate everything to the above decision.
- 4. Raise the constraint in the system.
- 5. Go back to step 1.

One searches for real reasons for the newly occurred problems by analysing the symptoms observed in the organisation activity. According to this logic one might find traces of making a diagnosis in medicine. While identifying the reasons for biliousness a doctor makes a diagnosis based on symptoms and examination results. Such an action is also applied in enterprises. The right diagnosis makes it possible to focus the activity on the area in which it is the most efficient.

## 2.7. ABCD Method

Another name for the ABCD method is the Suzuki method. It makes it possible to specify the significance and rank of particular problem causes. This method is very simple and widely used and needs active participation of a carefully selected team of employees. They are experts on their own fields and are knowledgeable about the This problem from their own experience. method might be used in all enterprises regardless of their activity profile and size. The ABCD (Suzuki) method might be applied if it is unknown which causes from their group have the smallest or even minimal influence on the analysed problem. Thereby, the method makes it possible to confine the scope of action by specifying the most significant causes that influence the analysed problem. Once the problem is defined and the work team is selected, the procedure is included in 4 stages:

Ordering the significance indicators from the smallest to the biggest value which makes it feasible for the work team to state which causes have the largest or an average or minimal influence on a given problem.

## 2.8. 8D Report

8D (8 Disciplines) is a methodology of solving problems related to the possibilities of improving products or goods. This method has 8 stages (Duffy L., 2013, p. 119-120) presented in Table 2.

Every step taken within 8D 's is significant and the next step efficiency is conditioned by its execution precision. The 8D's method is a combination of 3 elements: problem solving process, standardisation and the unified form of reporting results. The method is intended to identify, correct and eliminate repeating problems with goods quality. 8D is applied to analyse and solve both internal and external problems with the enterprise functioning. Their causes are unknown or their significance was not previously determined.

## 2.9. Scenario method

The scenario method might be applied to consider relations between events and the influence of an object on the environment. This method is used to form longterm quantitative or qualificative or material or non-material forecasts. The scenario should include such information as: the specification of hypothetical situations and their sequential future occurrence and the presentation of existing variants in the case of each event. The variants might facilitate the event occurrence or prevent from it.

The classification of the scenario methods into 4 groups is as follows: scenarios of possible events, simulation scenarios, scenarios of environment states and scenarios of environment processes:

1. The essence of scenarios of possible events is to make lists of events to be taken place in the future and the enterprise capacity to adjust to the above changes. The formation of a scenario related to the development of the situation in the environment is possible due to the design of an appropriate enterprise reaction.

2. Simulation scenarios make it feasible to make an advance value assessment in the case of particular strategic decisions dependent on the environment influence.

3. What the scenarios of environmental states provide is a generalised environment image and are qualitative by nature. The scenarios specify the influence of particular environment process on the enterprise and estimate the probability of their occurrence in the future,

4. The scenarios of processes in the environment are an extension of the environment state scenario method by focusing on the processes with a potentially large impact force on the enterprise.

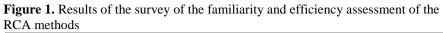
#### 2.10. Six Thinking Hats technique

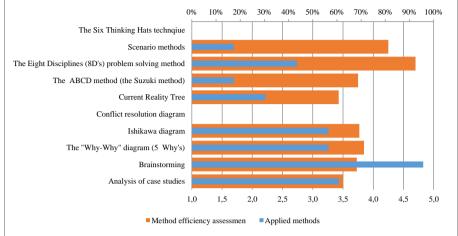
The author of the Six Thinking Hats technique is Edward de Bono and the technique is one of the creative thinking methods. Managers of contemporary enterprises encounter situations and problems which need to be solved by going beyond standard thinking frames. Therefore, modern management may be compared to "creative management" that needs not only creative imagination and analytical capabilities thinking. but also intuition. At the beginning it is required by the application of such techniques to appropriately formulate a problem that will undergo further analysis. It recommended to formulate problems by means of open questions (e.g. "How?" "Why?")

Edward de Bono distinguished 6 styles which people use in the thinking process. As regards to this method, all participants think in a parallel way which means that "all thinkers think in the same direction". The participants simultaneously adopt the thinking style assigned to each hat and express loudly their thoughts related to the ruling colour when the deliberation meeting is in progress. Therefore, each hat executes a different task (de Bono, 1985).

## **3. RESULTS OF THE RESEARCH ON APPLYING THE ROOT CAUSE SPECIFICATION METHODS IN POLISH ENTERPRISES**

One performed survey research among higher- and medium-level managers in Polish enterprises in order to investigate the application of the methods as described in chapter 2 and to get familiar with a subjective assessment of how efficient these methods are. The research embraced large and medium-sized production or logistic service enterprises that function all across Poland. 50 surveyed managers participated in the research that lasted the first 6 months at the turning of 2016 and 2017. Instrument used in survey was questionnaire send via e-mail. From 50 companies 40% are large and 60% are medium-sized companies. The performed research results are presented in Figure 1. Sebastian Wieczerniak, Piotr Cyplik, Jarosław Milczarek





Source: the authors' own elaboration based on the results of the survey research conducted at the turning of 2016 and 2017

The brainstorming method is the most popular and is used by more than 9 out of 10 surveyed managers. The next 3 methods are the analysis of case studies, "Why-Why" diagram, Ishikawa diagram respectively. All the mentioned methods are applied by more than 50% of the respondents but such methods as the conflict resolution diagram and the Six Thinking Hat technique are not used by the surveyed respondents. Interestingly, the rarely used 8D's report is the most efficient. As regards to the method efficiency hierarchy, the scenario method is at the second position and is used by only 15% of the managers. The efficiency assessment of the most frequently used method, i.e. the brainstorming method looks interesting. Although this method is the most frequently used, its efficiency assessment is rated 3.75 and it is the third result from the end. The results related to the managers' opinion on the 8D's method implementation efficiency inspired the authors to make considerations on its appropriate implementation in the enterprise.

#### 4. 8D's METHOD IMPLEMENATION AND APPLICATION

The 8D's is a multi-stage team actions that are referred to other methods and tools from the quality management area at each stage. Therefore, 8D's is an ordered process that forms an action scheme. The course of actions according to 8 steps should provide a solution to the quality problem by means of various methods and quality improvement tools. 8D's aims at defining and eliminating the causes of these problems. The 8D's method application makes it easier to determine the incompatibility cause and to give an opportunity to verify the completed actions. It should be emphasised that the focus in the 8D's method is put on team work by contrast to other problem solving schemes. The team work is essential to be successful in fulfilling action stages that require the knowledge not only about the mere production process or the product but also the specifics of the entire enterprise. This tool is very frequently used in modern industries or highly competitive industries where a large emphasis is put on the quality development (Dhafr, N. et al., 2006, p. 536-542).

The next action stages in the 8D's method are presented in table 2. (Chen, H.R. & Cheng, B.W., 2010, p. 339-350) indicated the tools and techniques that are most frequently applied in the practice of production enterprises. The tools and techniques might be applied at particular 8D's method fulfillment stages. In practice problem root causes proposed by single people are put in the 8D's report. The causes are not supported by available methods of broader team analysis methods, e.g. brainstorming, 5 Why?s and cause-and-effect diagram. In turn, this is related to the inappropriate selection of corrective/preventive actions.

8D's specifies a systematic approach to solving problems and documenting the solved problems. The 8D's disciplines/steps with their complementary tools or techniques are presented in table 2.

Method	Name of the stage	Stage fulfilment supportive tools and
stage	Tunie of the stage	techniques
D1	Establish a 8D team	Previous 8D's reports, Ishikawa diagram,
		diagram of relations
D2	Define and describe the	Previous 8D's reports, brainstorming,
	problem	control sheet, comparative analysis,
		histogram, Ishikawa diagram, FMEA,
		Pareto chart, ABCD method, process
		capability, SPC data
D3	Develop and implement	Previous 8D's reports, comparative
	interim containment plan	analysis, risk analysis, FMEA analysis,
		process capability, Gantt chart
D4	Determine, identify, and	Previous 8D's reports, FMEA analysis,
	verify root causes of the	Ishikawa diagram, diagram of relations,
	problem	matrix diagram, PSVA (Cyplik & Hadas,
		2011, LogForum 7, 1, 1.) and others
D5	Verify permanent corrective	Previous 8D's reports, ABCD method
	actions	
D6	Define and implement	Previous 8D's reports, flowchart, PDPC
	corrective actions	chart, Gantt chart
D7	Dressent reasonance	Providua 8D'a reporta EMEA apolyaga
D7	Prevent recurrence	Previous 8D's reports, FMEA analyses,
DO		Pareto chart, SPC data
D8	Congratulate your team	Previous 8D's reports,

**Table 1** Proposition of applying selected quality management tools and techniques at particular 8D's method stages

Source: the authors' own elaboration based on: Chen, H.R. & Cheng, B.W., 2010. A case study in solving customer complaints based on the 8Ds method and Kano model. *Journal of the Chinese Institute of Industrial Engineers*, 27(5), p. 339-350.

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The 8D's report chronologically presents the process of identifying corrective and preventive actions and ensures that the solutions, decisions and planning are based on protected data. The problem analysis by means of the 8D's method results in guaranteeing a real solution to the existing problems. The report might be used as a control of action progresses and includes data about both corrective and preventive actions and data related to verifying whether the implemented actions are long-lasting, efficient and effective (Michalos, G. et al, 2010, p. 81-91.)

In his publication 8D structured problem solving: A Guide to Creating High Quality 8D Reports Rambaud mentions what one should take into account while forming and developing an 8D's report (Rambaud, L., 2006). Both the guidance and the full process course related to completing the 8D's report are presented in table 3.

Responsibility	Process course
Department in which the problem was	1. Information on the problem. The 8D's report opening
diagnosed	Developing steps D0-D3
ulughosed	$\checkmark$
Quality department	D0
Quality department	Problem presentation. Description of symptoms.
	$\checkmark$
Quality department	DI
	D1 Team formation.
	$\checkmark$
Quality department	D2
	Presentation of symptoms by a person responsible for the problem
	occurrence area Problem identification.
Quality department	D3
Quanty department	Identification and implementation of temporary corrective actions
	(ICA - Interim Containment Actions)
	$\checkmark$
8D's team	D4
	Specification of a root cause or root causes.
	$\checkmark$
8D's team	D5
	Planning long-term (permanent) corrective actions
	(PCA Permanent Corrective Actions).
	Possible development of several alternative actions.
8D's team and the	v D6
person responsible	Implementation of long long-term improvement actions.
for the area	Introducing the most efficient and potentially effective actions.
	$\downarrow$
8D's team and the	D7
person responsible	D7 Implementing long-term and systematic actions that prevent the problem
for the area	reoccurrence.

 Table 2 "8D's" process course model

Responsibility	Process course
Quality department	<ul> <li>↓</li> <li>2.</li> <li>Closing the 8D and the information for the team on the 8D closure</li> <li>↓</li> </ul>
Quality department	D8 Appreciation of team achievements.

Source: the authors' own elaboration based on: Rambaud, L. (2006). 8D structured problem solving: A Guide to Creating High Quality 8D Reports, 1st ed., Breckenridge, CO: PHRED Solutions, 147.

Before the process of analysing the problem by means of the 8D's report method is commenced, one should collect input data and report the problem. Then the next number is assigned to the report and the report with the problem should be put in the 8D's report register. It is important to describe the problem symptoms in a precise way as they will be useful in the RCA.

Once the problem and its occurrence symptoms are precisely described, the first step is initiated, i.e. the team is established. Its leader should be a person from the quality department or a person responsible for the process with the identified problem. An expert on the problem occurrence domain should be an integral team member. If necessary, the remaining team members might get consulted by representatives of the problem-related areas. It is possible to adjust the team at each process moment dependent on the need related to particular stages or dependent on the identified root causes.

In the second step, i.e. D2, one should collect such input data as: precise problem description, figures, specifications of correct process patterns, known cases of flaws or incompatibilities. If possible, the results of analysing the incompatibilities should be collected. In cooperation with various enterprise departments one should present the inconsistencies and incompatibilities as precisely as possible. If the problem is repeatable, one should put the number of the earlier report and check what the conclusions were and what actions were previously taken. This aims at eliminating a situation in which one will take actions that did not bring the required result in the past.

The next 3D step aims at stopping unrequired problem effects. Once the problem and its effects are precisely analysed, one introduces actions intended to negative process results. The specification of the above actions takes place with the use of consultancies by a person responsible for the problem-included process component or with this person's participation. These actions result in stopping the increase of the problem results or a considerable decrease in negative effects implied by the incompatibilities.

Step D4 is a step related to the RCA by means of such available methods as FMEA analysis, Ishikawa diagram, diagram of relations, matrix diagram, virus analysis or other methods presented in chapter 2 in this article. When this step fulfilment is in progress, it is necessary to examine the data collected in step 2. If it is a repeatable problem, one should verify the results of analysing root causes in the

previous 8D's report. It is necessary to pay attention to the already defined causes and to verify whether there are no other previously undefined causes. If the problem gets repeated several times, one might use the Ishikawa diagram to find the inefficient problem detection cause. This will make it possible to eliminate the cause.

Once the source causes are specified, the corrective actions are specified and planned. These actions aim at eliminating the source causes. As regards to the actions planned in D5, they are intended to eliminate the problem causes by contrast to the D3 actions that should decrease or eliminate the problem effects. Similarly to the D4 step, one should check whether similar actions were implemented to the repeating problem. A particular emphasis should be put on the verification of the proposed actions before they are implemented in order to guarantee their effectiveness and efficiency.

In D6 one implements the actions that were approved in the previous step. A particular emphasis is put on validating selected long-term improvement actions after they are implemented. The D5 and D6 steps might be included in the 8D's report together although they have two separate process steps. One should precisely specify the action execution time and a person responsible for the execution.

When the cause is identified and the improvement actions are implemented, one should move on to step D7, i.e. to apply the actions that will prevent the problem to occur in the future. An example of this action is an undate of the control plan, procedures, instructions, process schemes and FMEA. In highly developed enterprises from the automotive industry one also applies a lessons learned tool.

In the last D8 step one should verify whether all the previous steps have been fulfilled and finished and the actions have been executed according to the plan and brought the planned effect. An appreciation of the entire team achievements is a frequently forgotten element of the entire process. The appreciation is of motivate value for the team for the sake of solving similar problems in the future.

The mere problem solving tool possession is not a success determinant. The tool needs to be implemented. The Kotter's 8-step method is the most structured one among numerous change management methods. This method was precisely described by Julien Pollack • Rachel Pollack (Pollack, J. & Pollack, R., 2015, p. 51–66) and is used in many areas of life which is proven by Gala L. and Hladik M. (Gala, L. & Hladik, M., 2016, p. 594-606). In table 4 there are stages with activities that support particular change implementation stages.

John	onn Kouer				
	Stage	Change accelerators			
1	Create Urgency	To make the team realise the urgency of using a big chance. This is of large importance for popularising the awareness that the enterprise needs constant strategic modifications. The modifications should always be suitable to the biggest chance in sight. As Kotter says, the feeling of urgency emerges at the hierarchy top and needs to be constantly confirmed and supported by managers to make the employees wake up every morning with a firm intention to act, execute tasks on the work day in order to approach the strategic			

**Table 3.** Accelerators in particular steps of the change implementation according to

 John Kotter

October 12-13, 2017 - Osijek, Croatia

	Stage	Change accelerators
	0	objective. The constant feeling of urgency gives a firm competitive
		advantage and might stimulate an army of volunteers and
		to maintain a dual operating system (the old and new one) in good
		shape. The feeling of urgency persuades the managers to focus on
		chances and makes it possible for the network to develop for the
		benefit of the organisation.
2	Form a powerful	To build and keep the change management team. The strategic
2	coalition	network core is the change management team that consists
	coantion	of volunteers from the entire enterprise. All the team members are
		equal to each other. No integral hierarchy makes the information
		transfer slower. The team might get familiar with the enterprise
		environment and interior, notice details and have a general
		panoramic view. The team might also use all the information to
		make decisions for the benefit of the entire enterprise. The decisions
		might be related to what strategic initiatives might be initiated and
		how to perform them in the best way,
3	Create a Visio of	To formulate a strategic vision and to grasp transformation
	change	initiatives intended to use the big chance. According to Professor
		Kotter the vision is a compass for the dual operating system. An ideal
		vision is achievable and easy to be communicated, emotionally
		attractive and strategically clever. The vision gives the change
		management team an idea of success, a sufficient amount of
		information and the feeling of direction. Due to the above the team
		might rapidly make consecutive decisions with no need to ask
<u> </u>	<i>a</i> .	permission questions at each bend.
4	Communicate	To present the vision and strategy in such a way that they command
	the vision	the employees' involvement and attract a bigger and bigger army of
		volunteers. If the strategy and vision are explicitly formulated and
		assume that a lot is at stake and the change management team
		promotes them in an authentically involved and haunting way, the employees will talk about them with no cynicism. The cynicism is
1		
		often awaken by messages that flow in a cascade-like manner
		often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation
		often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in
		often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the
5	Pamova	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment,
5	Remove	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances
5	Remove obstacles	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the
5		often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have
5		often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This
	obstacles	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting.
5	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor
	obstacles	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves
	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early.
	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early. The most certain success guarantee is given by fast, obvious and
	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early. The most certain success guarantee is given by fast, obvious and unambiguous victories that are explicitly related to the enterprise
	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early. The most certain success guarantee is given by fast, obvious and unambiguous victories that are explicitly related to the enterprise vision. The celebration of these trophies buoy up the volunteers and
6	obstacles Create short- term wins	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early. The most certain success guarantee is given by fast, obvious and unambiguous victories that are explicitly related to the enterprise vision. The celebration of these trophies buoy up the volunteers and persuade the employees to support the vision.
	obstacles Create short-	often awaken by messages that flow in a cascade-like manner through the consecutive hierarchy ranks. If the presentation is appropriately and creatively performed, it might get widespread in a virus-like way and will attract employees that will accept the ambitious message objective and get involved in its fulfilment, To accelerate the fulfilment of the set vision and chances due to involving the network in removing obstacles. In this case the team establishes cooperation with additional volunteers that have appropriate information from each domain related to the topic. This aims at fact and efficient acting. To celebrate fast, visible and important victories. In Professor Kotter's view people are not too patient so the proves of the strategic objective successful fulfilment should appear early. The most certain success guarantee is given by fast, obvious and unambiguous victories that are explicitly related to the enterprise vision. The celebration of these trophies buoy up the volunteers and

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	Stage	Change accelerators
		declaration of a victory. When the enterprise takes the foot off gas, cultural resistance increases and caucuses get established. Here it is clear once again why the change urgency feeling is so important in the functioning of strategic networks. The notion of the networks is explained in detail by Kotter in the reference article. This notion makes people act. If it is insufficient or neglected from the very beginning, the determination of the army of volunteers gets weaker and they will not resist the temptation to slow down the pace or even to stop. The volunteers will start focusing on their own work within the hierarchical structures and the hierarchy will prevail again.
8	Anchor the changes in corporate culture	To strengthen strategic changes in the enterprise culture. No strategic initiative – neither the big, nor the small one – will be complete until it is anchored in the enterprise everyday activities. A new direction of actions or a newly conceived method needs to sink into the enterprise culture. This will happen, if the initiative starts bringing visible effects and make the enterprise get closer to a strategically better future.

Source: The authors' own elaboration based on: Kotter JP (2012) Accelerate!: How the most innovative companies capitalize on today's rapid fire strategic challenges. Harvard Business Review 90: 43–58

One might conduct a change in each organisation by means of the 8-step change management and accelerators as presented above.

## **5. CONCLUSION**

Based on the data collected in the survey research it might be stated that there are a number of different methods to specify the root causes. Eight out of ten of the investigated methods were labelled to be used in a manager's work. Nevertheless, the 8D's report is the most highly ranked in terms of their efficiency. The 8D's report grade 4.7 given by the investigated managers. No other method was assessed as highly as the 8D's report. It is implied by the research that the 8D's report is not the most frequently applied method as it is placed at the  $5^{th}$  position among 10 investigated methods. The reasons for that were mentioned by the surveyed managers. In their view the above method assessment is caused by its multi-stage nature and time-consumption. The 8D's report is doubtlessly a more complex method than the brainstorming method which is the most frequently applied method to analyse root causes. As regards to the efficiency assessment, the brainstorming method is placed at the 6th position. An additional conclusion drawn from the feedback from the surveyed managers is that most of them stated that a combination of 2 or more methods was applied in numerous cases to solve one problem.

It is required by some of the mentioned methods to establish a team of experts or moderators. One group of methods has a precisely formalised methodology. Others are less formalised or not at all. In particular methods one might observe the scaling of problem determining factors or a visual presentation of results. Nevertheless, the managers, who use the 8D's report, emphasised that this method was the most complex one. It makes it feasible not only to identify the root causes but also to plan corrective, improvement and preventive actions. This enables systematisation of taken actions and a consequent retention of the problem effects.

The 8D method application is possible if the investigated system is a developed system - the epistemological level higher than zero (classification according to Cavallo (Cavallo, 1979)).

In the case of a system at the epistemological level 0, it is required to apply qualitative methods to its assessment due to the lack of data. When analysing the selected methods in this chapter one should state that none of them enables an honest analysis. In such a situation it is recommended to apply a virus analysis to assess the system at the epistemological level 0 (Cyplik & Hadas, 2015).

As part of analysing the system at the epistemological levels 1-3, the management steps as presented in the article will make it possible to effectively implement the 8D's report. Particular attention should be paid to the change accelerators that are a "flywheel" of changes. The omission or careless fulfilment of any Kotter's change steps will cause the planned change objective to be significantly different from the assumed level.

In order to further research into the effectiveness of RCA methods, questionnaires should be conducted in other European countries: both in developed countries and fast growing countries.

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