# BUSINESS LOGISTICS IN MODERN MANAGEMENT

## XIII. INTERNATIONAL SCIENTIFIC CONFERENCE

Osijek, 2013.

University of Josip Juraj Strossmayer in Osijek
Faculty of Economics in Osijek

# BUSINESS LOGISTICS IN MODERN MANAGEMENT

Faculty of Economics in Osijek
Osijek, Croatia
17 October, 2013

*Published by*
Faculty of Economics in Osijek

*For the Publisher*
Vladimir Cini, Ph.D., Dean of Faulty of Economics in Osijek



ISSN: 1847-361X,
ISBN:978-953-253-123-7 e-book on CD-ROM
Indexed in EconPapers

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**C O N T E N T**

# Foreword

International scientific conference Business Logistics in Modern Management this year takes place on the basis of cooperation between professors and researchers from Faculty of Economics in Osijek and professors and researchers from other universities and professional schools from Slovenia, Serbia, Hungary, Bosnia and Hercegovina and Croatia.

This thirteenth scientific Conference is organized within project Retail Trade in Value Chain of Food Products (010-0000000-3353) funded by the Ministry of Science, Education and Sports of the Republic of Croatian from March 1, 2008. In addition, at this Conference are participating professors and researchers from the universities from the above mentioned countries with which the Faculty of Economics in Osijek began more intensive cooperation in last year.

The first thematic block published papers that analyze trends in area of supply chain management from holistic point of view, network development, trust between supply chain members, ecology, to social responsibility.

In the second thematic block focus is on the distribution (especially retailing) and its role in the supply chain. New forms of retail business units in the value chain, new approaches in measuring inventory turnover in distributive trade, problems of distribution center's location and their role in green supply chain, and retail trade location problems are analyzed.

The third thematic area refers to the logistics case studies. It analyzes and evaluates logistics chains in Slovenia, advanced logistics systems in Serbia, problems of city logistics (example of Ljubljana), influence of NCTS and e-customs on savings in transit time and cost, and function of display pallet to optimize secondary distribution and merchandise handling.

Finally in the fourth thematic block authors deal with logistics technology and logistics education. Here are analyzed implementation of RFID technology in supply chain management, beergame reference scenarios for balanced scorecard evaluation from internal perspective, implementation of a visual kanban method for process management in the GrEta environment, monitoring the order picking processes with the Elli3 measurement tool, building of e-clusters, and synchronization of plotting board and computer based simulation in the frame of logistics process reengineering.

In Osijek, October 17, 2013.

Zdenko Segetlija, Ph. D.
Davor Dujak, Ph. D.

# I. SUPPLY CHAIN MANAGEMENT – TRUST, ECOLOGY, AND SOCIAL RESPONSIBILITY IN SUPPLY CHAIN

# HOW TO MORE HOLISTICALLY UNDERSTAND SUPPLY CHAIN MANAGEMENT?

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***Abstract***

In the global competitive environment, enterprises can survive in the long term by permanently improving their business. Usually, enterprises have limited resources and they face hard conditions; but they can significantly improve their business results if they manage their working better. The new challenges require from them a thorough innovation of management in general, including supply chain management (SCM). Most generally, we can define SCM as concept for managing the entire chain of raw material supply, manufacture, assembly and distribution to the end customer. But under fast socio-economic changes, SCM has faced the demand to develop and adjust continuously in order to contribute to efficient and successful work of the enterprise at stake. The fast development of the theoretical basis and the business practice of SCM open many questions connected to understanding and the definition of SCM. Therefore, in theory and business practice, we can find different approaches to research of SCM and different definitions of SCM. In the same time, the modern management is faced with the dilemma how to more holistically define SCM and how to more holistically understand different definitions of SCM. Based on above mentioned cognitions, our contribution discusses two research questions: 1) How to more holistically understand general framework of SCM, and 2) How to more holistically understand the methodological framework of SCM.

**Keywords:** content, management, methodology, supply chain management.

## 1. INTRODUCTION

Organizations in modern environment try to assure their existence and long-term development with the satisfaction of needs and demands of end-customers. Producers can be competitive on the modern global market, when they offer suitable: price, quality, range, uniqueness, and contribution to sustainable development as judged by customers (Etzioni, 1997; Baumol *et al*., 2007; Daft, 2009; Mullins, 2010; Certo & Certo, 2012).

Entire and innovative (understanding) forming and performing purchasing operations and physical distribution has also an important role in business (Harland, 1996; Cooper *et al*., 1997; Armstrong, 2006; Naslund &Williamson, 2010). They define the possible level of suitability when assuring the needs and demands of end-users. The use of logistic and material management in an organization enables partly improvement of work, but not (also) "optimization" of the whole production process of products and/or services (in which more organizations collaborate). To deal with the whole supply process many different integrated

concepts of managing across the traditional functional areas of purchasing operations and physical distribution were developed – i.e. materials management, merchandising, logistic, supply chain management - SCM (Lambert *et al.*, 1998; Shane, 2008; Chopra & Meindl, 2012; Deshpande, 2012).

Inside the entire problematique of the management of integrated concepts in the contemporary conditions, we will focus on the consideration of SCM (Potocan, 2009; Christopher, 2012). SCM shares a crucial impact over organizations competitiveness. Thus, SCM must attain the best possible efficiency, effectiveness, and sufficiency.

Management literature define SCM as presents ambitious and strategically significant managment concept, which can be defined as "managing the entire chain of raw material supply, manufacture, assembly and distribution to the end customer" (Mentzer *et al.*, 2001; Mullins, 2010; Chopra & Meindl, 2012; Manuj & Pohlen, 2012). SCM is the most developed integrated concept, but by its use, the organization meets some open dilemmas such as how to more holistically understand SCM, 2) how to create unified framework for researching of SCM, 3) how to create appropriate values-, general-, methodological-, content-, and context-related frameworks for consideration of SCM, and 4) how to more holistically examine SCM, etc.

There are many potential issues in tackling the holistic definition of SCM, creation of suitable frameworks of understanding of SCM and development of holistic examination of SCM. Among them, we will focus our attention on conceptualization, formulation, and application of broader and more unified general and methodological frameworks for discussion of SCM.

## 2. ORIGINS FOR CONSIDERATION OF SUPPLY CHAIN MANAGEMENT

In management literature authors reported about existence of many different definitions of SCM (Simchi-Levi *et al.*, 2007; Naslund & Williamson, 2010; Connelly *et al.*, 2012). This leads to the questions of how one should simultaneously learn to know and define similarities and differences between knowing definitions from more broader and unified consideration of SCM ((Douglas *et al.*, 1997; Potocan, 1998; Kannan & Tan, 2005; Potocan & Mulej, 2012).

Management theory and practice determine elementary environment for consideration of SCM (Mentzer *et al.*, 2001; Monczka *et al.*, 2008; Christopher, 2011; Bowersox *et al.*, 2012; Chopra & Meindl, 2012). On their basis we continue with discussion and development of a general framework for consideration of SCM. Authors try to attain unification of consideration of the tackled problems by using of different criteria, from which management literature primarily focused consideration on four criteria: (a) Prevailing theoretical perspectives – like functional, personality, behavior, etc., (b) Driving forces – like opportunity, resources, interests, etc., (c) Explaining theories – like social, technical, economic, etc., and (d) Important (selected) domains - like technological, socioeconomic, research, pedagogical, etc.

Mentioned criteria must be used as a synergetic entity for definition of the general framework, and hence, for support to a more unified consideration of any problem. The ways of taking the criteria into account depends also on considering persons. The results of application of the above four criteria are, therefore, additionally impacted by the following factors related to personal working and behavior (Armstrong, 2006; Buchanan & Huczynski, 2010; Lafley & Johnson, 2010; Thun, 2010).

Researchers must, before they use criteria, define the chosen contents, values and weight of selected criteria. Thus, they define their own content framework. This defines their own unified basis for definition of various ways of consideration and enables them to compare single ways of consideration with the others. The level of holism and behavior of considering persons has a crucial impact on the definition of contents.

The considering persons can use the above unified criteria for consideration of their problems at stake and though formulate different outcomes (i.e., several different, but correct) inside the selected criteria and values for general definitions of the problem. Every single potential solution reflects the definition of the problem from a selected viewpoint enabling a relatively objective basis for further specific consideration of the problem at stake. The considering persons select one from the set of possible solutions that is deemed to best match the values-, .methodological-, content-, and context-related basis for consideration of the selected problem in a synergetic style.

We face with the questions of how to – inside the definition of the/a general framework for consideration of SCM – clarify differences between several insights in SCM in both theory and practice. This clarification can result from understanding and definition of the existing values-, methodology-, contents-, and context-related differences of SCM as consequences of many objective and subjective factors and reasons behind them (Buchanan, Huczynski, 2010; Mullins, 2010; Chopra & Meindl, 2012, Deshpande, 2012; Manuj & Pohlen, 2012). For our work we clarify possible factors of differences in consideration of SCM in a most general approach into two groups: professional orientations and interest reasons (Potocan, 1998; Potocan *et al*., 2005; Potocan, 2009; Potocan & Mulej, 2009).

SCM can be viewed as a professional issue tackling many sciences and making them interdependent. But their findings are enabled, authored, and applied by decision makers and their teams. Hence, the scientific orientations and political (i.e., interest) viewpoints of SCM and orientations and interest in SCM are interdependent, too (Etzioni, 1997; Mulej et al., 2004; Potocan et al., 2005; Mulej, 2007; Buchanan & Huczynski, 2010).

The scientific/professional viewpoint includes attempts of attain a holistic definition of the basic attributes of SCM in terms of contents, methodology, and values if all crucial sciences cooperate. They depend on knowledge, experience, and professional orientations; this makes them (seem) quite objective and rational, if professionals act and behave holistically. For specialists without capacity and practice of interdisciplinary creative cooperation this is very difficult to attain.

The political viewpoint includes interests to be defined and concerted concerning the basic starting points. It should assure general preconditions for SCM to be implemented everywhere. Mostly, it depends on the network of different values and knowledge expressed as interests in a given period of time. Therefore, as a rule, the political aspect is rather subjective and irrational, because the western practice is rather one-sidedly argumentative rather than synergetic.

The dynamics of evolution of SCM provide for a further important reason for many different insights in SCM to exist (Wren, 2004; Armstrong, 2006; Mullins, 2010; Certo & Certo, 2012). Attributes of these dynamics can be clarified if we understand SCM as depending on time, the development level of science and knowledge, and the prevailing attributes of both the social and natural environments of SCM. It has paralleled changes in the perspectives and level of development of attributes of single time periods in societal development – like prevailing values, culture, ethics and norms, the important sciences for SCM working - especially knowledge about production, management, industrial

engineering, etc., and prevailing conditions and preconditions of environments in which SCM works. The dynamics of development of SCM enable also an insight in, explanation, understanding, and consideration of the concept of how various scenarios of working of SCM can be applied. Thus, we can find out inconsistencies between the current understanding of SCM and the prevailing understanding of SCM in a given environment, discover the positive and/or negative gaps between them, and formulate the necessary measures to overcome these gaps.

Application of the presented insights enables us to define, in the most general terms, the general content framework of SCM. This framework provides a basis for the further development of a relatively, perhaps even holistic and unified, framework for the understanding of SCM as a base for a unified and sufficiently comparable consideration of different insights into SCM.

There are many potential issues in tackling the definition of the framework and its use for SCM research. Among them, we will focus on the bases and basic attributes of the conceptualization, formulation, and application of a holistic and unified methodological framework for SCM.

## 3. METHODOLOGICAL FRAMEWORK OF CONSIDERATION OF THE SUPPLY CHAIN MANAGEMENT

We continue with discuss about different methodological approaches for research of SCM. Most of these approaches have dealt with complicated rather than complex SCM constructs; they tried only recently to stress relations between parts of reality, which mostly used to be considered in separation and, hence, one-sidedly rather than holistically and with synergies earlier (Bertalanffy, 1950; Wiener, 1956; Beer, 1979; Foerster, 1987; Checkland, 1999; Mulej *et al.*, 2004; Wallis, 2009).

Management authors for definition of methodological framework use several approaches from the traditional approaches to systems approach, and according to their selected viewpoints (Etzioni, 1997; Armstrong, 2006; Daft, 2009; Mullins, 2010; Buchanan & Huczynski, 2010; Certo & Certo, 2012). Generally, they take either any one of the traditional approaches or the systems approach.

Management theory emphasizes systems approach as most interesting and promising, and necessary preconditions for sustainable development of humankind (Baumol *et al.*, 2007; Potocan & Mulej, 2009; Mullins, 2010). If one adds, in order to be less abstract and closer to reality, the consideration of the influential role of the selected viewpoint/s and of humans defining them, one can closer to an array of the different, less traditional systems theories. In this case, interdependence between relations inside the entity under consideration is visible, but it is extended to the relations between the object under consideration and the humans dealing with it. This applies to working of organizations in general and in SCM, too.

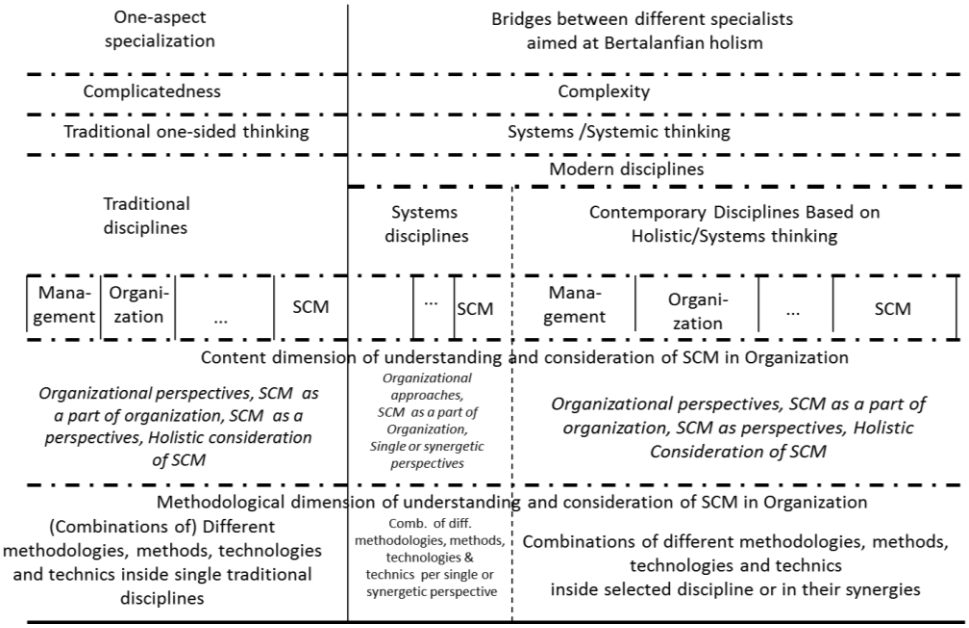
Holistic understanding and researching of SCM in organizations is also related with understanding of interdependence and synergetic working of: 1) The working reality of organizations, 2) Systems thinking – as the methodological approach enabling more or less holism of understanding the organization practice, and 3) SCM construct – as methodology of impacting the working reality.

At the same time, there is a need for a requisitely holistic consideration of organization as an entity/system made of the network/system of: (a) general, (b) group-specific, and (c) individual attributes. On these terms, one can formulate SCM a specification of the general and the group-specific attributes of working and behavior of organizations related to the individual operational part of their activity.

In terms of methodology, SCM can be defined on the basis of its (a) specific area, and (b) specific methods of dealing with this area. This means application to organizations and adding to it the organizations-related specifics in order to holistically deal with working issues of organizations from the crucial viewpoints inside the selected systems of crucial viewpoints. In terms of methodology, SCM applies selected content to organizations based on selected (systems of) viewpoints, purposes, goals, methods, methodologies, context of use, and characteristics of its users.

Our understanding of possible ways for creation of different SCM constructs is presented in Figure 1.

Figure 1 Our way to understanding of the traditional and modern SCM in the methodological framework of modern science




Source: our own work

Presented figure expose several issues related to different approaches for methodological consideration of SCM.

One-aspect specialization is the most usual type of education, because there is so much knowledge that every individual unavoidably focuses on a small fragment of it – as stated different authors (e.g. - Checkland, 1999; Francois, 2004; Mulej, 2007; Potocan & Mulej, 2009; Wallis, 2009). This is no problem if a transition to over-specialization does not result, making its owner incapable of interdisciplinary creative cooperation and, therefore, of holism reaching beyond a single viewpoint. Thus, the entanglement of single parts of the entity under consideration can be studied well (i.e., complicatedness) while complexity is left aside because it covers relations between an entity's parts and between the given entity and its environments. Many important synergies may, therefore, become victims of oversight, including crucial ones. This outcome can be ascribed to the traditional approaches of the industrial period and paradigm. Crises are caused by the traditional, one-

sided behavior of humans, although reality is full of interdependencies rather independencies. On such a basis, the traditional scientific disciplines arose covering many details much better than the big pictures. Their approach causes many important insights and equally many important oversights. Related scientific methodologies are equally specialized and only exceptionally applied in combination or even synergies.

Bertalanffy (1950), therefore, felt as if he were talking "uncommon sense" when he established his General Systems Theory (Bertalanffy, 1968; Davidson, 1983; Checkland, 1999; Mulej, 2007; Wallis, 2009). He perceived the dangers resulting from one-sidedness for humankind and, as he said he had created his General Systems Theory against over-specialization —that is, as the worldview and methodology of wholeness (Bertalanffy, 1950; Bertalanffy, 1968; Davidson, 1983). However, we did not find in his writing that wholeness of insights and other outcomes of human work depend on holism of approach, which can be attained by interdisciplinary creative cooperation. Similarity, called isomorphism, that he mentioned serves well in the case of transfer of knowledge from one specialized discipline of science or profession to another, but less so for interdisciplinary creative cooperation. In particular, it does not support complementary relationships of mutually different specialists. Thus, disciplines and professions can remain isolated from each other. Therefore, complexity of reality remains outside scientific and practical observation if the Bertalanffian values of wholeness do not receive more methodological support than from the General Systems Theory and if it is used only for a formal description of an object under consideration under the name of a system.

In decades after the creation of the General Systems Theory, many systems theories and Cybernetics were created (Beer, 1979; Foerster, 1987; Checkland, 1999; Lewin, 2000; Francois, 2004; Wallis, 2009). They can be grouped into three groups. First group includes Hard systems theories (and Cybernetics), applicable in engineering and natural sciences and practices. Second group includes Soft systems theories (and Cybernetics), applicable in social and humanistic sciences and practices. Third group includes Integrative systems theories (and Cybernetics), applicable for integration of mutually different and, hence, complementary sciences and practices. The 1 and 2 groups support the requisite holism and wholeness when single viewpoints of single disciplines and practices are deemed sufficient. They do contribute to good outcomes, but less so to mastering of the real-life complexity and complicatedness rather than complicatedness only. Thus, the group 3 is essential for humans to control complexity (Mulej et al., 2004; Potocan et al., 2005; Mulej, 2007; Mulej & Potocan, 2009). This applies to SCM, too.

SCM is worked on, if we take a look at various authors referenced here, with either one or the other of the three approaches (Mentzer *et al.*, 2001; Bowersox et al., 2012; Chopra & Meindl, 2012). Some authors still see SCM as an engineering topic, such as the followers of Taylor's' scientific management, Fordism, or Weberism in SCM – different authors discuss about this problem like Simchi-Levi and Simchi-Levi (2007), Monczka et al. (2008), Naslund and Williamson (2010). Other authors feel closer to the soft systems approach, such as the followers of social relations, human relations, or human resources concepts in SCM. Concepts incorporated in the modern, non-bureaucratic applications/concepts are close to the integrative systems theories in SCM.

Once we define the methodological framework for the understanding of SCM, we face new dilemmas. They tackle the content of SCM, such as: which steps have constituted the contents framework of SCM; what is the contents framework of SCM like; what are the links between methodological and contents framework like, etc. But detailed discussion

about content-related framework of SCM exceeds selected limitations of our consideration in this article.

## 4. SOME CONCLUSIONS

SCM is in forefront of majority of management discussion in theory and in business practice in last twenty years was. But attempts of a holistic consideration of SCM with a unified framework for understanding of it in the modern environments are relatively new. Under the fast socio-economic changes, SCM has faced the demand to develop and adjust continuously in order to contribute to efficient and successful work of the organization at stake. The fast development of the theoretical basis and the working practice of SCM open the questions connected to its understanding and definition.

In working reality, organizations try to simultaneously learn to know and define similarities between different definitions of SCM in order to define the unification of consideration, and learn to know and objectively clarify differences among definitions as a basis for understanding the potential differences in consideration of SCM.

Researchers of organizations' SCM create a general contents framework of SCM as a conceptual basis by consideration of: the prevailing theoretical perspectives, driving forces, explaining theories, and important and selected domains. On the other hand, researchers also try to clarify differences between many different insights in SCM on the basis of understanding: the objective and subjective factors of SCM and reasons/forces behind them and dynamics of the evolution of SCM. They do so, on the basis of research of SCM as a function of time, a development level of science and knowledge, and the prevailing attributes of important environments of SCM.

We used the general, content-related framework to investigate the creation of a general methodological framework. On the basis of conceptual starting points, theoretical cognitions and our experiences form business practice we can define three basic groups of methodological understanding and consideration of SCM - i.e., basic methodological frameworks, such as earlier research of SCM, the earlier systems researches of SCM, and modern holistic researching of SCM.

The suggested "holistic definition of methodlogical framework of SCM" for research of the role and importance of SCM in modern organizations opens some new managerial dilemmas connected with the terminology of SCM, and especially about an actually holistic understanding of systemic and process understanding and content of SCM.

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# OVERCOMING PERCEPTIONS OF UNCERTAINTY AND RISK IN E-RETAILING

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***Abstract***

Increasing development of the Internet and the use of information and communication technology contributed to the development of e-retailing in consumers' purchasing. The main purpose of this paper is to explore overall perceptions of e-retailing among Croatian consumers. In particular, the focus of the paper is on the areas which influenced the customer commitment and loyalty in e-retailing. In understanding whether the Internet and home shopping affected consumers' purchases and what is the level of acceptance of e-retailing comparing to traditional, brick-and-mortar stores, the quantitative study on the sample of 392 consumers was conducted. The on-line questionnaire was designed specifically to find out consumers' acceptance of e-shopping, factors affecting their on-line shopping behaviour, consumers' perceived usefulness of e-retailing, etc. The findings of this research indicate that consumers use on-line purchasing more than two years ago but that they still do on-line purchasing activities with a significant level of uncertainty and distrust.

**Keywords:** e-retailing, trust, risk, uncertainty, consumers, Croatia

## 1. INTRODUCTION

In increasingly competitive retailing markets, being able to retain consumers and influence their loyalty is seen as the key factor in winning market share. A veritable explosion occurred in new types of store formats, competing each other on the same market, for the same segment of consumers. Therefore, consumers are taking into account different factors in evaluation and making their choice of the retail formats. They continue to buy in various brick-and-mortar store formats but they start to introduce on-line purchasing for some type of products and services, č2as well. Consumers discovered the enormous potential of e-retailing (McKnight et al., 2002) and home shopping. Several factors have influenced the growth of their popularity, such as: access and the number of households purchasing personal computers (Newmann & Cullen, 2002), easy comparison of competing products and prices which helps in finding the best offer (Finne & Sivonen,

2009), overall costs reduction (Luarn & Lin, 2003), etc. There is a growing body of literature concerning factors which encourage consumers to use Internet shopping facilities and electronic commerce customer relationship management. Previous research (Wang et al., 2001) has shown that such factors as ease of use, information content, innovation, security protection, customer support, product/service itself, and transaction process will influence Web customer satisfaction. However, there are some areas which cause problems in e-retailing consumers` acceptance, such as uncertainty about product quality, incomplete product information (Ba & Pavlou, 2002), a lack of trust in the technical and institutional environments surrounding the Web (McKnight et al., 2002), etc. Trust plays a central role in helping consumers overcome perceptions of risk and insecurity (McKnight et al.,2002, p. 334). The importance of trust is magnified in the highly uncertain e-commerce environment (Wang & Pho, 2009).

The paper is organized as follows. First, a brief literature review is given to provide a background of the study. In the section that follows, a discussion on research methodology and results of the study are given. Finally, a discussion of theoretical and managerial implications including limitations of the study and directions for future research are presented.

## 2. LITERATURE REVIEW

It is worth noting that literature sources on the topic of consumers` acceptance of e-shopping are very often related to risk and uncertainty elements. Risk and uncertainty are constructs included in interacting with an e-vendor (Gefen et al., 2003). Some researchers have suggested that online customers generally stay away from e-vendors whom they do not trust (Reichheld & Schefter, 2000), while most researchers also agree that trusting beliefs directly influence repeated purchase intentions (McKnight et al., 2002; Kim & Benbasat, 2003). The perceived risk of having one's personal identity or financial information stolen by hackers (O'Brien, 2000) can deter Web site use. Choi and Lee (2003) empirically showed that increased level of perceived risk reduces purchase intention.

Perceived transactions risk considerably affects e-shopping (Lee & Clark, 1996). Moreover, the protection of privacy is an issue of increasing concern (Liao & Shi, 2009). Individuals may be reluctant to use e-business for the fear of unauthorized or illegal duplication and circulation of information (Keeney, 1999). Cunningham et al. (2005) empirically proved that perceived risk is a significant factor in relation to consumer behavior.

From a detailed reading of the literature on consumers` acceptance of e-retailing, we observe the following. Academic researchers tend to focus on the structure of trust-building mechanisms, while practitioners tend to focus more the trust-building mechanism, especially in terms of technical solutions and implementation.

Kim et al. (2005, p. 144) conclude that trust has been identified as a key component in marketing and e-commerce literature, as in the worth mentioning works of Beatty et al. (1996), Hoffman et al. (1999), and Jarvenpaa et al. (2000). According to Urban et al. (2000), consumers make Internet purchasing decisions on the basis of trust. There are differences in the concept of trust in electronic commerce (e-commerce) and in traditional businesses that involve brick-and-mortar stores (Kim et al., 2005, p. 144). In brick-and-mortar retailing, trust is based on personal or business relationships and interactions between the consumer and the merchant at an individual or a firm level. In e-retailing, trust

is based on the consumer's confidence in the processes and is especially critical when two situational factors are present in a transaction: uncertainty (risk) and incomplete product information (information asymmetry) (Swan & Nolan, 1985). Uncertainty in e-retailing is often related to the product quality which is avoided in a traditional business setting. Buyers in online marketplaces have to rely on electronic information without having the ability to physically check the product; hence, they are vulnerable to additional risks because of potentially incomplete or distorted information provided by sellers (Lee 1998). The lean nature of the electronic environment relative to the traditional face-to-face market leads to transaction risks rooted in uncertainty about the identity of online trading parties or product quality (Ba & Pavlou, 2002, p.243). Information asymmetry may give rise to opportunistic behavior such as misrepresentation of product quality, which could lead to mistrust or even market failure. Koller (1988) argues that trust is a function of the degree of risk inherent in a situation. McKnight et al. (2002, p. 337) propose that consumer subjective probability of depending involves the projected intention to engage in three specific risky behaviors—provide the vendor personal information, engage in a purchase transaction, or act on vendor information (e.g., financial advice).

According to Jin (2010, p. 30), service quality contained in e-retailing affects both perceived value and customer trust. Namely, good service will lead to customer trust and improve perceived value. Sultan and Mooraj (2001) indicate security as the service quality factor which is linked to trust. The same authors also point out that customer trust could be improved due to advanced security technologies of a Web site.

The concept of perceived value is a general judgment of a product or service associated with perceptions of expense and payback. It is the balance between the use-value of the products or services and the cost such as time, money and emotion (Jin, 2010, p. 30). Perceived value is assessed by the consumer and based on simultaneous considerations of what is received and what is given up to receive it. Clearly, certainty and lower risk related to time, money and quality of product/service and a Web site are logical drivers of perceived value.

Switching costs could be also observed as an important segment of certainity and risk taking in e-retailing. Switching costs refer to the time, money or emotion that customers will spend when switching from one service provider to another (Jin, 2010, p.30). As the majority of reviewed researches were conducted in Western countries, it was interesting to compare their findings with the findings of this research. Consumers in Western countries demonstrate less trust in online shopping than Croatian consumers which can be probably attributed to several reasons: more sofisticated fraud techniques in Western countries and higher number of online shoppers generates higher interest in online frauds. Since Croatian e-tailing is its infancy, greater trust of Croatian consumers's can also be attributed to beginners' infatuation with novelty called online shopping.

## 3. RESEARCH METHOD

For the purpose of this paper, a research study examining the overall perceptions of e-retailing among Croatian consumers, the level of confidence in on-line purchasing, the areas which influenced the customer commitment and loyalty in e-retailing, etc. on the sample of 392 Croatian consumers was conducted. The method used in this study was an on-line questionnaire. The questionnaire consists of three sections. The first section consists of statements related to consumers` acceptance of e-retailing (such as, perceived usefulness

of e-shopping, the level of confidence, the fear of unauthorization and information asymmetry, etc.). The second section includes question about the lenghts of on-line shopping and the most frequent bought assortment. The third section is devoted to demographics of the sample (results are shown in Table 1).

Whenever possible, we developed items measuring the constructs by adapting existing scales developed and tested in previous research. As the original items were in English, we asked two researches whose native language is English to check the translation validity.

The level of trust in on-line purchasing was adapted from the model proposed by McKnight et al. (2002). Perceived usefulness was adapted from the study of user acceptance of information technology (Davis, 1989; Davis et al., 1989).

All the research constructs were measured using multiple-item 5-point Likert scales adapted from previous studies, with strongly disagree (1) and strongly agree (5) as the anchors. The research was conducted during May 2013. A total of 392 completed questionnaires were received, a response rate of 78.4%.

The collected data were analyzed using relative and absolute frequency analysis.

Table 1 Demographics of sample (Total sample=392 respondents)

| Item | Percentage |
|---|---|
| *Place of residence* | |
| Large town (more than 100.000 inhabitants) | 59.93 |
| Town (less than 100.000 inhabitants) | 27.05 |
| Village | 13.01 |
| *Gender* | |
| Female | 61.99 |
| Male | 38.01 |
| *Age (Years)* | |
| 18-24 | 16.78 |
| 25-34 | 61.64 |
| 35-44 | 18.15 |
| 45-54 | 2.74 |
| 55+ | 0.68 |
| *Education* | |
| Unfinished Elementary | 0.0 |
| Elementary | 23.63 |
| High school | 10.62 |
| College/University | 36.64 |
| Master degree | 23.63 |
| Doctoral degree | 5.48 |
| *Occupation/Employment status* | |
| Industrial worker | 65.07 |
| Owner of the company | 7.53 |
| Unemployed | 10.96 |
| Pensioner | 0.34 |
| Student | 16.10 |

Source: survey

## 4. RESULTS AND DISCUSSION

According to the data in Table 2, the largest percentage of respondents recently started with on-line shopping. Namely, 29,45 percent of respondents are practicing on-line shopping only 1-2 years, while 27,40 percent are doing it some 2-4 years.

As the number of product categories sold via Internet is continually growing, it was interesting to find out what categories Croatian consumers usually buy on-line. The results in Table 2 show that clothes, airplane tickets and travelling services are the most preferred ones.

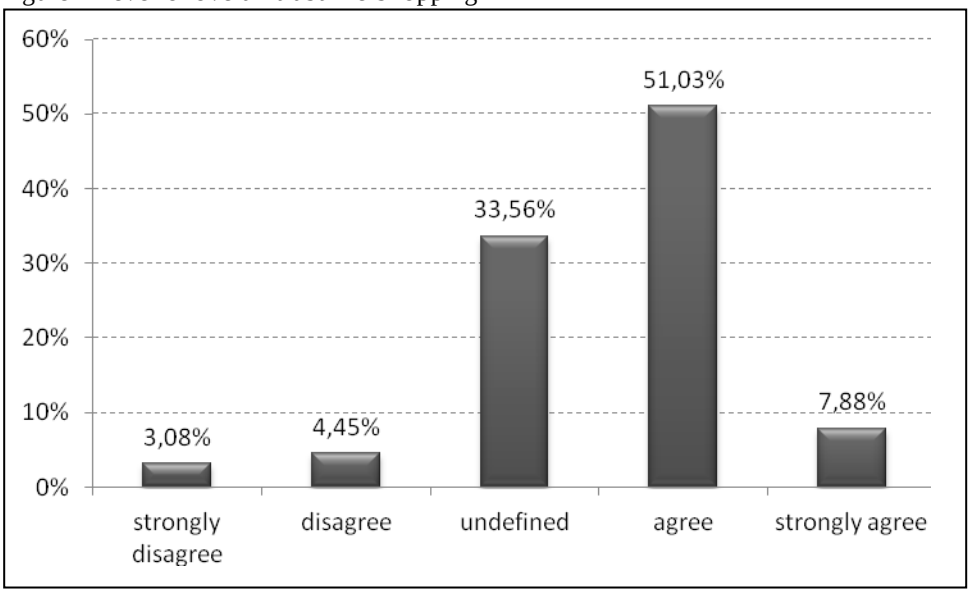
Table 2 Specifics of e-shopping

| Item | Percentage |
|---|---|
| *Length of on-line shopping* | |
| less than 1 year | 17.81 |
| 1-2 years | 29.45 |
| 2-4 years | 27.40 |
| 4-6 years | 11.30 |
| more than 6 years | 14.04 |
| *Mostly bought product categories* | |
| Clothes | 29.45 |
| Cosmetics | 7.19 |
| Food/drink | 3.42 |
| Books/DVD/CD | 15.75 |
| Computers, softwares | 19.18 |
| Travelling, airplane tickets | 25.00 |

Source: survey

The overall confidence in e-retailing is pretty high. As Figure 1 suggests, 51.03 percent of respondents showed trust in e-shopping. However, there is also high percentage of respondents who are undefined whether to have confidence in this type of shopping or not.

Figure 1 Level of overall trust in e-shopping



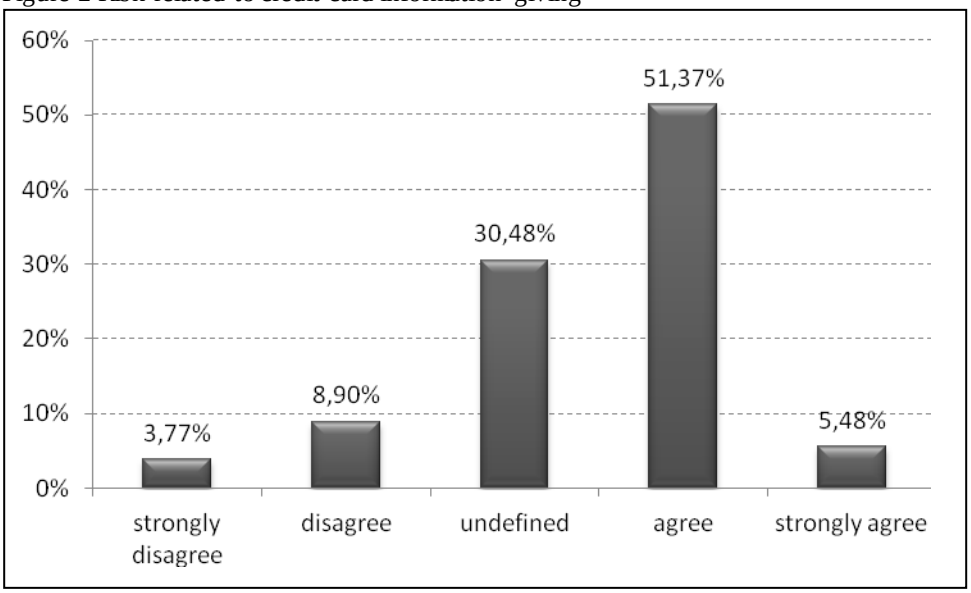

Source: survey

As we were interested in the development of confidence in e-retailing, respondents were asked to compare their current level of confidence in e-shopping with the level they felt two years ago. According to the results, 56,85 percent of respondents have higher level of confidence in e-shopping than two years ago. Only 10,96 percent of respondents do not trust today e-shopping more than before. Consumers' trust is also correlated to product categories bought online. The greatest trust consumers demonstrate when buying Books/DVD/CD and Travelling/airplane tickets, while least trust is demonstrated when buying Clothes and Cosmetics. Reason for this probably lays in the fact that Books/DVD/CD and Travelling/airplane tickets are usually bought from well-known websites while Clothes and Cosmetics are usually bought from untrustful websites with questionable reputation, driven by low prices of famous brands. Results show that trust is related to specific brand of the product but this is correct only in case these brands are bought from trustful websites.

53.42 percent of respondents believe that vendors use their data ethically acting in the their best interest, trying to help and being genuinely concerned. However, there is still 31.51 percent of respondents who are not so sure about Web vendors in general.

It should be noted that 49 percent of respondents who rely on on-line product information and 44.87 percent of respondents who believe in on-line product description. However, there are a still high percentage of those who are not sure (41.44 percent of respondents) in the description of product available on Internet.

Figure 2 Risk related to credit card information giving




Source: survey

The last question in the first section of the questionnaire asked respondents to indicate perceived trustworthiness of e-retailing. More than half of the sample (51.72 percent of respondents) consider that e-shopping is certain and without risk. However, we should bear in mind that there is still considerable percentage of those who were undefined (38.36 percent of respondents) in trustworthiness of e-retailing.

## 5. CONCLUSION

Based on the results of secondary data analysis, we may conclude increased uncertainty and risk associated with online transactions. Perceived risk factors have been considered important in online transactions. Additionally, previous researches show that such factors as ease of use, information content, innovation, security protection, customer support, product/service itself, transaction process will influence e-shopping customer commitment. This paper is an attempt to explore overall perceptions of e-retailing among Croatian consumers and the level of their acceptance of e-shopping, factors affecting their on-line shopping behaviour, consumers` perceived usefulness of e-retailing, etc. The findings suggest that Croatian consumers consider e-retailing not so risky and they have higher level of confidence in e-shopping than two years ago. However, we should bear in mind that there is still considerable percentage of those who were undefined (38.36 percent of respondents) in trustworthiness of e-retailing.

One important implication for managers involved in e-retailing, that comes out of this research, is that they need to focus their attention on the “development” of constructs of loyalty and commitment. It is important that they invest in the trust-building mechanism and to investigate their feedback mechanism as well. Future research should take a more extensive approach to cover all possible positive and negative antecedents of risks and trust

in e-retailing. Moreover, as with most research, caution must be exercised when generalizing the results. Additional research is needed to generalize our findings.

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# THE ROLE OF TRUST IN THE FOOD SUPPLY CHAIN

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***Abstract***

Dimensions of supply chain relationships such as trust, commitment, co-operation, communication and adaptation play a vital role for a successful and efficient flow of products and/or services. As recent scandals in the field of food industry have shown, this phenomenon has not received enough attention. Namely, studies of supply chain relationships have primarily focused on relationship processes as such, but have failed to acknowledge their impact on all relevant parties or the overall reputation. Hence, in light of relevant studies the present paper aims to identify and discuss problems in relationships between different parties in food supply chain in Slovenia, from the consumers' viewpoint. More specifically, the objective is to examine the role of trust as seen in Slovene consumers' reactions to food scandals in Slovenia (and Europe) covered by different media. The findings indicate that consumers not only mistrust the institutions responsible for food safety and quality assurance, but also the claims on products.

**Keywords:** food supply chain, trust, food industry, consumers.

## 1. INTRODUCTION

The new food economy is characterized with greater concentration of farms into smaller number with large sizes, increased emergence of contract farming, and the evolution of integrated supply chains linking producers and consumers. Such developments bring about new characteristics, which create new challenges for sustainable production and

processing practices that promote a balanced approach to the food quality, safety, and good environmental stewardship issues (Opara, 2002, p. 101). In recent years, much media attention has been given to the area of food supply chain (FSC), particularly following the new food politics and growing public concern over the manipulation of foods, which have led to a drastic fall in public trust. Following the most recent horse meat scandal, public trust in the food industry was found to have dropped by 24%. Moreover, 30% of those polled indicated that as a result they are buying less processed meat and fewer ready meals with meat in or are choosing vegetarian options. In addition, confidence in food safety was also found to have dropped quite drastically, from 92% feeling confident when buying food products in the supermarket prior to the scandal being revealed in the press to 72% feeling confident now. (Thomas, 2013)

Such events have a negative impact on relationships within the food supply chain with resulting levels of inter-organizational mistrust (Stevenson and Pirog, 2013, p.2). However, in line with the fierce global competition in this area companies seek to buy as cheaply and sell as lucrative as possible. The dimensions of FSC relationships such as trust, commitment and communication between consumers, on the one hand, and other FSC players such as suppliers, processors, retailers and the like, on the other hand, are becoming increasingly important. Here, the media play a key role, in that they hold food scandals (from BSE scandal, GM food scandals, horse meat scandals etc.) in their recurrent focus (cf. Siipi and Launis, 2009; Bohm et al., 2009).

This paper explores the perception of trust by the consumers and its role in FSC. More specifically, in this article theoretical knowledge will be used to understand the nature and functioning of FSC with the objective to identify and discuss the role of trust in relationships between different parties in FSC, i.e. between consumers, on the one hand, and suppliers, processors, retailers and the like, on the other hand. The main objective is, therefore, to examine which players the Slovene consumers find least trustworthy following a particular food scandal.

This paper is structured as follows: first a theoretical overview is provided, followed by a description of the methodology used. Then, based on recent scandals in the area of food consumption (potential) trust issues in FSC relationships between the aforementioned parties will be discussed. In conclusion, implications of the findings will be drawn.

## 2. THE CONCEPT OF FOOD SUPPLY CHAIN (FSC)

According to the Global Supply Chain Forum, supply chain management (SCM) is defined as: "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders" (Lambert and Cooper, 2000, p. 66). In this respect, Stevenson and Pirog (2013, p. 1) define FSC as "a network of food-related business enterprises through which food products move from production through consumption, including pre-production and post-consumption activities". Typical links in the supply chain are: inputs ➔ producer ➔ processor ➔ distributor ➔ wholesaler ➔ retailer ➔ consumer. For example, a FSC featuring pork products might include feed suppliers or veterinarians, a cooperative of farmer producers, meat packing and fabrication plants, food distributors/marketers, supermarkets and consumers, whereas preproduction activities might include university-based R&D. Similarly, post-consumption activities could include waste disposal and recycling, while government regulations would likely be engaged throughout the chain.

Furthermore, supply chain analyses have been increasingly focusing on examination of pre-production links such as agricultural research (e.g. genetics) or post-consumer links (e.g. waste disposal and recycling).

The nature of relationships between various participants in the FSC in general has been explained in a number of different theoretical approaches: transaction cost theory, political economy theory, social exchange theory and resource dependence theory (Robicheaux and Coleman, 1994). The primary focus of these approaches has always been on the nature of relationship processes rather than the effect of these relationships.

According to Dwyer et al. (1987), relationships evolve through five general phases: (1) Awareness; (2) Exploration; (3) Expansion; (4) Commitment; and (5) Dissolution. For the purpose of this study, we are particularly interested in commitment, as it is influenced by co-operation which arises from the presence of trust. As the relationship develops and expectations continue to grow, the parties in FSC begin to bond so as to encourage maintenance or facilitation of a relationship (i.e. they become committed). More specifically, the focus will be on the way, in which trust issues may arise from the reactions of readers (i.e. potential consumers) on reports about food scandals.

## 3. THE CONCEPT OF TRUST

There are a number of definitions of trust (cf. Anderson and Narus, 1990; Geyskens and Steenkamp, 1995; Moorman et al., 1992; Shapiro, 1987 etc.) Lewin and Johnson (1997, p. 28), for instance, define trust as the "willingness to rely on an exchange partner in whom one has confidence". This means that a party that trusts other parties has confidence in them and relies on them what leads to higher levels of loyalty and long-term benefits (cf. Lindgreen, 2003, p. 313). Moreover, levels of trust are influenced by the accuracy and degree or amount of open, honest and clear information exchange that takes place in those relationships. Icasati-Johanson (1999) was one of the first to develop a definition of trust in the context of supply chain relationships, defining it as the belief that in an exchange relationship, under conditions of risk and interdependence, trust is a voluntarily accepted duty that will prevail ensuring that no party exploits the other's vulnerabilities (Icasati-Johanson, 1999, p. 9). In this respect, aspects of communication behaviour, especially accuracy, adequacy and credibility of information exchanged between the players are crucial to the success of relationships, and communication has been found to be of utmost importance in the development of trust (Icasati-Johanson, 1999). It is, therefore, not surprising that food scandals frequently dent public trust in food and parties on the other end of the food supply chain. Hence, trust needs to be repaired. Given that trust develops over time, this process is not likely to be easy.

To avoid potential losses of trust that may occur for various reasons, greater transparency and food traceability from producer to consumer are needed. Traceability, in particular, can help detect and prevent food safety hazards and preserve the identity of novel foods, and has become an essential element of a quality assured FSC management system. Namely, traceability has been identified as a preventative strategy in food quality and safety management, particularly when hazards or food scares occur, in which case a good traceability system will facilitate timely product recall and determination of liability. The capability for a comprehensive traceability at any stage in the FSC is considered critical to addressing decreased consumer confidence and general public concern about the series of food-related incidences. Technological advancements such as data capture, storage

and retrieval, non-destructive testing, geospatial science and technology provide opportunities as well as challenges in this area and have greatly contributed to the development of technological innovations for traceability throughout the FSC (Opara, 2002). Opara (2002) further asserts that from a consumer perspective, traceability helps to build trust, peace of mind, and increase confidence in the food system. For other FSC players, traceability is part of an overall cost-effective quality management system that can also assist in continuous improvement and minimisation of the impact of safety hazards, by rapidly determining and isolating its sources. Furthermore, it facilitates prompt and effective recall of products (Opara, 2002).

Here, various institutions and the government (at national and EU level) also play an important role in this process, in that they monitor various parts of the FSC process or enforce industry wide standards concerning food quality control.

## 4. METHODOLOGY AND BACKGROUND

Following a series of food scandals throughout Europe and worldwide in the past decade, consumer trust in the safety and quality of food have been challenged. To examine, which players have lost most credibility from the consumers' viewpoint, we have selected a number of media reports on food scandals in Slovenia (and beyond). Data were taken from the two largest national news website portals 24ur and RTV Slovenija.

(1) In February 2011, the maximum permitted level of sulphur dioxide for dried apricots (produced by Noberasco) was exceeded. Comments on one article reporting about the event were analysed
(2) In February 2011 traces of glass have been found in apricot marmalade. Retailer announced a warning for those who have already bought the product and the marmalade has been removed from the shelves. Comments on one article reporting about the event were analysed.
(3) In June 2011, has the world medical organization announced the news about the new strain of bacteria E.coli which is highly contagious. Scientists have not yet discovered the source of infection, but they suspect mainly fresh vegetables within EU. Comments on one article reporting about the event were analysed.
(4) In February 2012, an animal feed scandal broke out, when aflatoxins were discovered in the milk of cows that fed on mouldy grain on some of Slovene farms. Drinking such contaminated milk can have serious health implications. Comments on five articles that reported about the event were analysed.
(5) In June 2012, has been found the presence of bacteria in French cheese, which causes listeriosis. This is a serious disease which can last up to eight week. Comments on one article reporting about the event were analysed.
(6) In January 2013, tea for weight loss was subject to a recall from the market, since it contained dangerous sibutramine, which can cause heart disease and even stroke. Comments on one article reporting about the event were analysed.

The data are qualitative in nature. The dataset consists of a total of 100 readers' comments, which appeared underneath the online versions of the articles about a particular food scandal. The selected comments were analysed and coded independently by three researchers to identify and overcome potential differences and difficulties in interpretation of the content and categories. The categories were developed based on descriptions, which

were grouped and labelled by the researchers on the basis of similar features. Any disagreements between the researchers were resolved in discussions.

The number of comments by the readers was much higher; however, we chose to investigate only those user responses that specifically addressed trust issues towards one of the players in the FSC. To this end, communication among users themselves that did not address any trust issues has not been taken into account in this study.

## 5. DISCUSSION

Table 1 shows the frequencies in each category for a specific "breakdown of trust" that was reported by the reader when commenting on the story that covered a particular incident. Regardless of the type of scandal that occurred, the most widespread breakdown of trust was found to be in the institutions, especially the government and the legislation adopted at the level of the European Union, followed by the breakdown of trust in corporations and global market chains. On one occasion, corruption of inspectors was brought to light, Here, distrust in the pharmaceutical corporations and the industry as such was frequently emphasized. Several readers blamed the profit-driven manipulations of particular actors.

Table 1. Categorised frequencies of breakdown of trust obtained from readers' comments

| Category | Indicator name | Frequency | Percentage |
|---|---|---|---|
| | | | |
| FOOD SUPPLY CHAIN | Breakdown of trust in the entire agri-food chain | 4 | 11,5% |
| | Breakdown of trust in one of the national FSC players (farmers /manufacturers/ national food industry/ retailers) | 10 | |
| | | **14** | |
| | | | |
| INSTITUTIONS | Breakdown of trust in national institutions (VARS) | 3 | 53,2% |
| | Breakdown of trust in the government and the EU | 32 | |
| | Breakdown of trust in corporations and global market chains | 25 | |
| | Corrupt inspectors | 1 | |
| | Other manipulations (profit-oriented) | 7 | |
| | | **65** | |
| | | | |
| MEDIA | Questioned credibility of the article | 7 | |
| | Breakdown of trust in the media (misleading information etc.) | 12 | 15,6% |
| | | **19** | |
| | | | |
| IMPORTED FOODS | Breakdown of trust in imports from China | 2 | 11,5% |
| | Breakdown of trust in imported products | 12 | |
| | | **14** | |
| | | | |
| OTHER | Breakdown of trust in consumer rights | 1 | |
| | Hampered competitiveness of Slovene farmers | 4 | |
| | Breakdown of trust in claims on product labels | 3 | 8,2% |
| | Reference to other malpractices | 1 | |
| | Terrorism | 1 | |
| | | **10** | |
| | **TOTAL** | **122** | |

## 6. CONCLUSION

Food industry is faced with severe challenges as customers are making new demands in products and becoming more self-assured, therefore putting pressure on suppliers. Because of various food scandals consumer trust has been even more undermined. FSC therefore reveals major challenges in culture and behaviour of each individual party in FSC in food industry.

Based on the findings it becomes quite clear that consumers are highly sceptical about the safety of food products and that confidence of Slovene consumers in the food industry has been seriously dented. This calls for an improvement of relationship with consumers, a more transparent food supply chain, and the need to source more of the products locally when reasonable.

FSC and its every interdependent party requires redesign, especially in the field of communication, transparency, ethics and especially guilt and responsibility acceptance in order to provide superior customer value at the lowest possible costs. The latter must of course help the government, the legislation and competent services.

A significant opportunity exists to better meet demands through developing better information systems and tailoring service provision.

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# THE INFLUENCE OF CORPORATE SOCIAL RESPONSIBILITY ON SUPPLY CHAIN MANAGEMENT

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***Abstract***

The concepts of supply chains and the integration of organizations which are part of them are being increasingly observed and stressed. The same applies to the concept of corporate social responsibility, which is nowadays seen as essential for maintaining of economic, social and natural environment. However, it is rarely considered how these two concepts influence one another and how they can be combined in order to create a new paradigm for protecting the triple bottom line: "People-Planet-Profit".

In this paper we try to explore the relations between the concepts of corporate social responsibility and supply chain management, where we particularly focus on the opportunities that this combined concept brings to today's business environment, when we are surrounded with threats of crisis, layoffs, bankruptcies and on how we can fully use knowledge from both fields to provide a future to organizations and their supply chains, employees and the environment in which they operate.

With implementing a necessary holistic style of thinking, we'll add to the supply chain management system, which is inherently a highly multidisciplinary system, a dimension of necessary and sufficient social responsibility of organizations operating in the chain, thus presenting new opportunities for a socially responsible supply chain.

**Keywords:** supply chain, corporate social responsibility, holism, systemic management

## 1. INTRODUCTION

Every day, numerous activities in every supply chain have impacts that have a wider influence than just on the products and services that are the focus of the chain. Here,

implementing principles of corporate social responsibility comes into consideration to ensure minimal negative and maximal positive supply chain impacts. Both topics, supply chains and their management as well as corporate social responsibility, have seen an extensive rise in actuality and research in the last decade. However, little is written on the effects of one on the other or on the possibilities which implementing social responsibility principles to supply chain management brings. Therefore, the main aim of this paper is to present a short overview of both topics separately and then offer some insight into the necessity of combining these two practices and into the possible positive outcomes. The authors will mainly rely on a review of the literature from both fields to present topics to the reader and then, based on this, will develop the notion of supply chain social responsibility.

## 2. SOCIAL RESPONSIBILITY

Social responsibility is a concept that is increasingly encountered in the business sphere. The most used phrase is corporate social responsibility or social responsibility of the enterprises. Social corporate responsibility represents the ability to use knowledge of social responsibility in one's field of work. It is one of the main factors of building success and reputation of modern organizations. It represents an awareness that the organization is responsible for their own acts and problem solving, which has influence on the people and wider business and social surroundings of the organization. Organizations can interpret social responsibility in different ways, based on their goals, values and culture of the higher management, which should be explained and made clear to employees, the social environment and the organization. In supply chains, which link together a various number of different organizations from different fields of business with different goals and ways of managing, common understanding of social responsibility becomes a major challenge for all the stakeholders.

A major step forward in this area was made with the ISO 26000 standard, which was approved by ISO - International Standardization Organization. It covers all the points of view of social responsibility, which organizations should be aware of and think on while organizing and managing their operations. The standard consists of guides and principles, but it's not meant for certification purposes. One of the most important contributions of the standard is the definition of social responsibility, which states: “Social responsibility is the responsibility of the organization for the effects of its decisions and activities to the society and environment through transparent and ethical behaviour, which:

- contributes to sustainable development, including health and wellbeing of society;
- takes expectations of the stakeholders into consideration;
- is in accordance to laws and consistent with international norms of behaviour;
- is integrated to the entire organization and reflected in its internal relations.” (ISO, 2010)

This definition follows until now valid definitions of different organizations, for example the European Commission, World Business Council for Sustainable Development and Global Reporting Initiative, where a key focus, as pointed out by Castka and Balzarova (2007), is on providing optimality of three key areas: economic, environmental and social. Elkington (1998) named this threesome of successful and responsible business the “triple bottom line” or the concept “People-Planet-Profit”. In accordance with this, there are five priority areas mentioned by Elkington:

- human rights;
- rights of employees;
- environmental protection;
- inclusion in the community;
- relationships with suppliers.

Especially relationships with suppliers are the foundation of functioning of supply chains, which we will further explore later in the paper. It's also important to explain that the concept of social responsibility, especially in the field of logistics and supply chain management, is often replaced with the concept of "sustainability" (Carter & Rogers, 2008).

Basic concepts of organization's functioning, as defined by ISO 26000, are (ISO, 2010):

- responsibility (especially for the own influence on society, economy and environment),
- transparency (especially about the decisions and activities that can impact the society and environment);
- ethical behaviour (which is based on values of honesty, equity and integrity);
- respect for stakeholder interests;
- respect for the rule of law;
- respect for international norms and behaviour;
- respect for human rights.

Ethical behaviour of organizations is important in the way that ISO 26000 defines it, which is "behaviour that is in accordance with accepted principles of right or good conduct in the context of particular situation and is consistent with international norms of behaviour" (ISO, 2010). Sustainable development, which represents the key component of corporate social responsibility, is defined by ISO 26000 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (ISO, 2010).

ISO 26000 also describes the concept of supply chains, and defines them as "sequence of activities or parties that provide products or services to the organization" (ISO, 2010). More about supply chain and their social responsibility will be explained in the following chapters.

## 3. SUPPLY CHAINS

Almost 20 years ago, Stewart (1995) recognized the need for the transfer from functional-oriented supply chains towards integrated supply chains, which required philosophical, operational and system changes. Mentzer, DeWitt, Keebler, Min, Nik, Smith and Zacharia (2001) have shown the increasing incidence of the concept of supply chain and the beginning of an intensive understanding of the organizations as links in the supply chains. Although a uniform and common definition of the concept of supply chain still doesn't exists, as the gap between them is mainly in the area of defining the included flows, we can use the generally applicable definition of Mentzer et al. (2001): "a supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer". Same authors define supply chain management as "the systemic, strategic coordination of the traditional business functions and the tactics across

these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."

With a change in thinking about supply chain management, questions about dependencies between each part of a supply chain, their responsibility and influence, are being raised. This change of thinking on the field of management and integration has brought awareness about the importance of connecting, integration and cooperation between all links in the supply chain, which are part of bringing products and services to the end customer. With development of different concepts about supply chain management, different requirements about necessary points of view that need to be taken into consideration while functioning also arise. Social responsibility is one of them, and nowadays, together with economical success of supply chains, it is becoming the key element for efficient supply chain operations and their existence.

### 3.1. Social responsibility of supply chains

Supply chains that include material flow, services and other supporting activities from first supplier to end customer and back, are largely based on connections between stakeholders and the establishment of trust between them. With vertical integration of the customers and suppliers we can achieve higher potential for successful supply chain operations and for satisfaction of end consumers. One of the foundations of successful supply chain management is compliance with their holistic nature, which Cruz (2009) applies also on social responsibility in them: "Each stage in the supply chain gives rise to its own effects, impacts, and opportunities for improvement, but effective corporate social responsibility strategies require an analysis that encompasses the entire supply chain. It is important for any firm in the supply chain to take a network approach to the investment in corporate social responsibility. The network approach would benefit all members of the network and require lower individual investment in corporate social responsibility." We can draw clear parallels between holism in supply chain management and holism in social responsibility management. Even more, in modern supply chains management of social responsibility of supply chains has to be the part of holistic supply chain management.

Carter and Jennings (2001) developed the term "purchasing social responsibility" in the context of social responsibility in supply chains. They determined that with involvement of purchasing officers in organizations and in whole supply chains in the processes of social responsibility, direct and positive effects on the success of suppliers is developed. With integration of socially responsible suppliers into supply chains of the organization, trust in suppliers and the whole supply chain is increased. Therefore authors determined that the social responsibility of the organization is one of the key factors with which certain supplier can achieve higher trust and better relationship with their (existing and potential) clients.

But nowadays, when consumerism requires from suppliers that product and services are the best, that they have the lowest price and they satisfy a high spectre of additional requirements, manufacturers and service providers are confronted with more and more challenges. Other point of view is the fact that activities of suppliers and intermediate customers in supply chains are directly reflected on the reputation of final sellers and on the reputation of products or services that are offered on the market. One of the most known cases of this type of unethical behaviour from the supplier side that was reflected on the brand and final seller is the case of the Kathie Lee Gifford brand and Wal-Mart, which is described by Bond, Spekman, Kamauff and Werhane (2006). The company advertised the

mentioned brand as products that are Made in USA only. After a production line of the clothes in Honduras was disclosed, consequences were so grave that not only the name of the company and the brand were harmed but also some exclusions of shares of the company from some investment portfolios were made. Of course, this case is not the only one; we can find them in supply chains all over the world.

We can conclude that monitoring of supplier's activities through the whole "downstream" supply chain is crucial for operations of the whole supply chain and also for the reputation of all links in the supply chain. Currently, most well-established way of monitoring all activities of the supply chain is a structured approach to risk management throughout the supply chain. We can also look at this from reverse point of view – if the organizations want to operate in a socially responsible way, they have to include risk management techniques that arise from guidelines of socially responsible business management. Faisal, Banwet and Shankar (2006) identified 11 factors that influence supply chain risk management success, where one of the most important is social responsibility of all links in supply chain. The most important is awareness that the acts of organizations and supply chains influence a wide spectre of stakeholders, therefore also the overall awareness about the importance of socially responsible operating and implementation of actions for pursuit of common goals of social responsibility.

Spence and Bourlakis (2009) named integrated promotion of social responsibility of all organizations that are involved in supply chain, regardless of their position in it, "supply chain responsibility". This concept covers the entire supply chain and its consideration of and response to questions beyond the narrow economic, technical and legal requirements of supply chain management with the purpose of achieving higher social and environmental benefits that are complementary to the traditional economic objectives of these chains. We can assume that this type of functioning largely depends on the level of trust and integration between the various links of a supply chain – a strong social responsibility of the supply chain can be achieved only on fundamentals of socially responsible organizations, so first each link should take care of its sufficient social responsibility, and then social responsibility of the chain can be built. Spence and Bourlakis (2009) identified four necessary conditions for successful integration of social responsibility in supply chains:

- a chain-wide commitment to achieving social (and environmental) benefits,
- the legitimacy and possibility of all links in the chain to have a voice,
- genuine partnership approach,
- acknowledgement of different approaches to ethics by different organisational forms within the supply chain.

We can conclude that the connection between supply chains and their social responsibility does not entail a substantial shift in the management of mutual requirements and relationships; it just means an upgrade and expansion of them. This facilitates decision of organizations and supply chains for introducing the principles of socially responsible business in their operations. Even though the principles of socially responsible business can be implemented progressively, all partners in the chain have to show a common goal from its beginnings, which is achieving a level of corporate social responsibility of all organizations and the supply chain as a whole, which will ensure the economical survival of the organizations and also the environment in which they operate, the preservation of social and natural potential.

## 4. CONCLUSION

Nowadays, not one organization can exist without being connected to and dependant on other organizations, which forces them to inevitably influence them and be influenced by them. The operation of such supply chains can be limited only to material and service flows, or there can be higher levels of integration. This contributes to increasing the trust between participants of the supply chain and also increases the chances of survival of participants and whole supply chains in increasingly harsh economic conditions.

Global business, consumerism and the need for sustainable operations and management; all this are modern phenomena to which organizations and supply chains have to adapt. Supply chains that were connected and interacted between each other only because of economic benefits, will have to cooperate because of different requirements of customers and consumers – they will have to become socially responsible if they wish to maintain (or obtain) competitive advantage and satisfy a wide spectre of wishes of end consumers, and ultimately to survive in the environment in which they operate. Based on our research, we can claim that this shift from merely cohabiting and cooperating to being socially responsible as a whole supply chain should not (and in fact does not) represent a major shift of business operations, it represent an upgrade of supply chain relations and a needed step towards long term survival of all supply chain participants and their respective environments.

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# GREEN LOGISTIC EFFORTS WITH V2G AND B4H SOLUTIONS

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***Abstract***

There is a strong need to provide green fuel for transport purposes. One of the candidate solutions is the hydrogen energy, but there are many challenges the prospective hydrogen economy is facing with, especially from the logistics point of view. There are rapid developments on the field of electricity driven vehicles in the same time. According to the actual trends, the first stage of green fuel penetration seems to be the Vehicle-To-Grid integration, where electrically driven vehicles are able to download and upload energy from and to the national grid. The limited range of electric vehicles can be extended by using quick charging applications or hybrid on-board energy storage technologies. In our essay we present how the V2G and B4H solutions can exceed the main barriers of alternative fuel vehicles.

**Keywords:** Hydrogen, V2G, fuel station network, B4H

## 1. INTRODUCTION

Nowadays the transportation sector is one of the largest energy-intensive sub-systems. As the economies develop, there is an observable increase in the demand for transportation – both in the passenger and freight sub-sectors. Transportation is responsible for most of past and expected future growth of world oil demand, and because transport is 97% dependent on petroleum, these developments could have important impacts on oil markets and carbon dioxide emissions. The transportation sector has the highest rate in total crude oil consumption, and the need for oil is continuously growing.

On the way of searching for alternative fuels the hydrogen seems to be a probable winner, but there are strong competitors, like bio-fuels or electricity from renewable sources. The second chapter gives an overview about the challenges of the development of

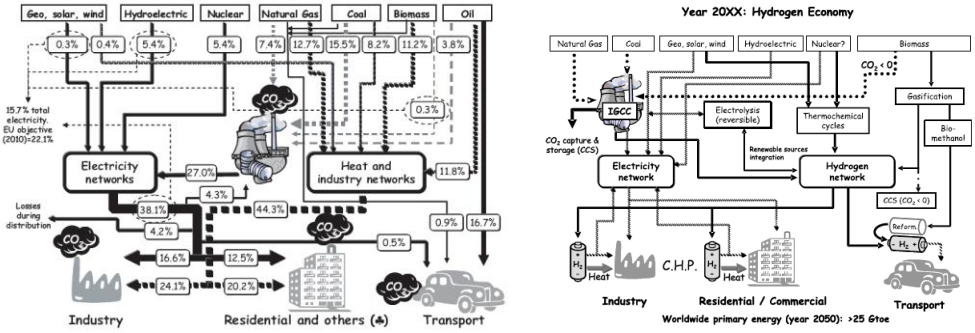
hydrogen economy. Electricity driven vehicle fleets can contribute in the more efficient usage of the existing electric power infrastructure – as will be presented in the third chapter. The fourth chapter contains the analysis of the above mentioned hydrogen and V2G infrastructures alongside the main barriers the alternative fuel systems need to overcome. As a conclusion, we can highlight the pathway of infrastructure developments towards green fuel economies.

## 2. INFRASTRUCTURE DEVELOPMENTS ON THE WAY TOWARDS THE HYDROGEN ECONOMY

Hydrogen and its use for energy production purposes have long been in the focus of attention. The hydrogen economy has a promise to build up an environment friendly energy system based on renewable sources in the production, and zero-emission vehicles at the end-user side.

Using hydrogen as a transportation energy carrier has been widely, but not universally, touted as a key solution for many of the environmental and geopolitical problems associated with burning petroleum-based fuels such as gasoline and diesel. Hydrogen FCVs will have zero emissions of criteria pollutants in urban areas, can be significantly more efficient than conventional vehicles, and permit the use of domestic energy and low carbon resources for fuel production. Hydrogen vehicles must, however, overcome a number of challenges, technical and economic, in order to become a feasible option for consumer light-duty vehicles. (C. Yang et al. 2008)

Figure 1: The traditional energy supply and the prospective hydrogen economy




Source: Marbán, et al., 2007

There are several scenarios, roadmaps, and similar foresight papers in the literature of hydrogen research. The key for technologically and economically feasible plans is to consider the logistics and distribution system of hydrogen as the part of the existing energy systems. The success of hydrogen pathways are depending on the availability of the critical infrastructure. While most technological issues can be accommodated within the existing technical knowledge and industrial practice, the main obstacle is the cost involved in hydrogen energy system development. Considering the pivotal role that the infrastructure for production and distribution will play in the diffusion of hydrogen as a transport fuel, many studies on this topic can be found in the literature. As may be expected, several approaches have also been used to assess the importance of the factors - social,

environmental, economic and juridical - which will affect the diffusion of hydrogen in the transport system. (Agnolucci et al., 2007)

Hydrogen may enable transport sector diversification using energy produced from renewable, nuclear power, and clean fossil fuel technologies. The literature describes a diverse range of possible future scenarios, from decentralised systems based upon small-scale renewable, through to centralised systems reliant on nuclear energy or carbon-sequestration. Several models and scenarios have been developed for wind-hydrogen, nuclear-wind-hydrogen systems, and these simulations give insights in feasibility and competitiveness. A lot depends on the availability of fossil sources (amounts and prizes) and also on the market value of electricity and hydrogen, which could not be predicted easily.

There is a broad consensus that the hydrogen economy emerges only slowly. Rapid transitions to hydrogen occur only under conditions of strong governmental support combined with, or as a result of major "discontinuities" such as shifts in society's environmental values, "game changing" technological breakthroughs, or rapid increases in the oil price or speed and intensity of climate change. A variety of early niche markets are either recognized or advocated as providing an important stage for the development of a hydrogen economy. (As an example, the benefits of applying hydrogen driven urban buses were proven in the CUTE Clean Urban Transportation for Europe Project). Most of these early markets or technologies are described as overcoming cost barriers, by providing niche applications that allow learning and scale economies, as well as increasing public familiarity.

## 3. V2G – VEHICLE TO GRID

Using electric and hybrid-electric vehicles is becoming popular recent days, as we can see on the example of Toyota Prius, Tesla, and many other cars. The superiority of electricity-driven vehicles (trains, trams, trolleys, forklifts) both in their performance and environmental impact is widely accepted. Apart from the electricity-driven vehicles, the infrastructure for their use is also rapidly developing, such as chargers and battery systems, smart parking and charging stations. (Kvasz et al., 2010)

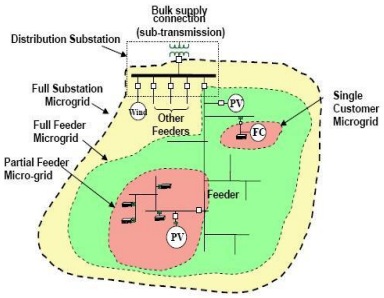
Most of the electric vehicles have a battery storage system of 4kWh or more. It is possible to recharge the battery from an external source, and the owners are able to drive around 40-80 km in electric mode. The hybrid-electric vehicles are able to run on fossil fuels, electricity, or a combination of both leading to a wide variety of advantages including reduced dependence on foreign oil, increased fuel economy and power efficiency. They can lower greenhouse gas (GHG) emissions by running on renewable electricity.

There is a new upcoming technology: the Plug-in-Hybrid electric vehicle (PHEV). These technologies include hybrid-electric vehicles (HEVs), fuel cell vehicles (FCVs) and battery electric vehicles (BEVs). Collectively, these options can be categorized as electric-drive vehicles (EDVs), because they all have the capability to produce motive power from electricity. The Toyota Prius car originally was designed as a hybrid electric vehicle (HEV), but it can be converted into a plug in hybrid electric vehicle (PHEV) using an aftermarket kit. (Today it is being manufactured as HEV and PHEV as well). These trends are supporting a new type of application: as vehicles can store a certain amount of electrical energy, they can take part in the electricity grid balancing activities.

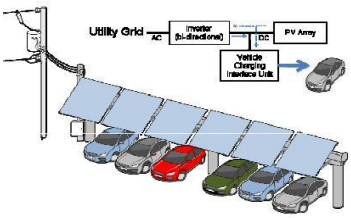
The V2G concept is one of the attractive ideas to synergize the electricity and the transportation sector. This concept with pure electric and hybrid-electric vehicles (which are capable to connect to the grid and load-unload electrical energy) could help to manage electricity resources better, and it empowers vehicle owners to earn money by selling power back to the grid when parking, depends on the current fuel and electricity prizes. One factor which suggests such benefits is the fact that private vehicles are parked on average 93-96% of their lifetime, during which time each represents an idle asset. Each parked vehicle contains under-utilized energy conversion and fuel (or battery) storage capacity, and may actually create negative value due to parking costs. Accordingly, generating V2G power from parked vehicles can better utilize an expensive investment (particularly in the case of new and alternative vehicle technologies), thereby enabling cars to provide both mobility and energy services. Since average vehicles in the US travel on the road only 4-5% of the day, and at least 90% of personal vehicles sit unused (in parking lots or garages) even during peak traffic hours, the existing 191 million automobiles in the United States would create 2865GW of equivalent electricity capacity if all the vehicles supplied power simultaneously to the grid — an unlikely occurrence, because this amount was more than twice than the total nameplate capacity of all US electric generators in 2006.

Figure 2. V2G systemdesign

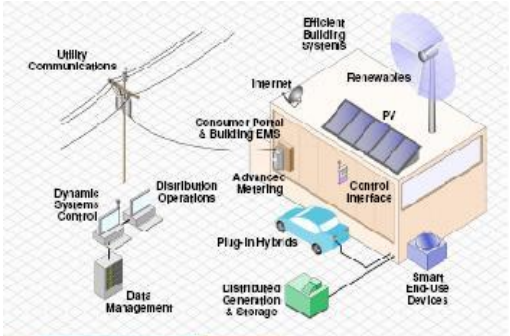
a)




b)




c)




Source: a) (Kroposki, 2009.); b), c) (Duvall, 2009)

Vehicle-to-grid (V2G) technologies represent a potential opportunity to bring forward and accelerate a transition towards electric-drive vehicles by improving the commercial viability of new vehicle technologies. (Tomic et al., 2007)

## 4. BARRIERS

We need Alternative Fuel Vehicles, but there have historically been six major barriers to AFV success (Romm, 2006). The comparison of V2G and hydrogen vehicles and fuel distribution infrastructures alongside these factors is bringing new insights of necessary developments.

### 4.1. High first cost for vehicle

The price of electric or hybrid-electric cars is higher than the conventional ones. Since electricity is a relatively cheap fuel, the payback depends on the yearly driven distance and the lifetime of the cars, especially the battery units. In special applications (public transport, city logistics, waste management, etc) or in special areas (over-crowded city centers) the additional benefits of zero-emission vehicles are bringing external cost reductions, but it is hard to estimate and build up compensation tools.

At the case of hydrogen cars the first cost is also high. The entrance points at the market today are opened only in the luxury category.

### 4.2. On-board fuel storage issues – limited range

Using batteries in electric vehicles is widely accepted, but there are discussions about the ecological footprint of damaged battery units. The other problem is the limited range of these cars at the absence of quick recharging possibilities. A technological breakthrough in reduced weight, improved storage capacity and re-procession of old battery packs can decide the competition, but it is questionable if these results will be reached in the near future.

At the case of hydrogen cars the range can be extended by increasing the volume of the hydrogen tank. There are many new developments on the field of hydrogen filling, what is going nearly on the same way like at the case of conventional vehicles. The lifetime of fuel cell units is longer, compared with the available batteries. Various solutions exist for on-board hydrogen storage:

- Liquid H2 on-board storage suffers from high distribution costs and significant energy losses.
- Gaseous H2 at up to 800 bars has lower energy losses for storage, but there is a trade off between vehicle range, fuel tank size and compression energy.
- Binary metal hydrides are also under investigation, and recent studies suggest that binary metals, notably aluminium and lithium boron compounds could achieve up to 15 mass percentage H2 storage density

Hydrogen road vehicles today either have gaseous onboard H2 storage (usually compressed at high pressures or sometimes in metal hydrides) or liquid cryogenic onboard storage. While liquid and gaseous storage are proven technologies, binary metal hydrides and carbon nanotubes are still in a laboratory stage (Züttle et al., 2002.) More advanced solid state storage systems based on advanced metal hydrides or on carbon materials (nanotubes) are in development, but they are not forecasted to be commercial for at least another decade.

### 4.3. Safety and liability concerns

New solutions often meet public scepticism. Although an electric car use the same type of battery like a well-known cell phone, people think that they could be shocked by electric current, or the battery might catch fire. That is why demonstration projects (public transport applications) are important, and would deserve more support from the governmental side.

The situation is nearly the same with the hydrogen vehicles. While gaseous H2 offers the advantage of higher well-to-wheel efficiency and somewhat simpler technology (lack of liquefaction plants; lack of super insulating storage devices), its disadvantage arises from the high pressures involved, posing some potential safety risks. On the other hand, liquid H2 has the bottleneck of boil off during parking, and therefore needs different safety concepts. Despite the hydrogen as a fuel is totally safety, people have fears about using in road vehicles.

### 4.4. High fuelling cost (compared to gasoline)

Gasoline stations are existing solutions for conventional fuels, but electric and hydrogen vehicles require special equipments in distribution, storage and filling. The rate of return depends on the number of filling points and the amount of electrical or hydrogen energy distributed through the network.

### 4.5. Limited fuel stations: chicken and egg problem

Considering the chicken and egg problem at the case of alternative fuel vehicles the question appears: What will be the first? (Melaina et al., 2003)

1. Costumers will not purchase fuel cell vehicles unless adequate fuelling is available.
2. Manufacturers will not produce vehicles that people will not buy.
3. Fuel providers will not install hydrogen stations for vehicles that do not exist

The development of the new infrastructure will depend on the location of consumers, primary energy sources for electricity or hydrogen production, and the storage and distribution facilities.

Electricity is available nearly everywhere, but the distribution system has to be re-engineered with increasing rate of electric vehicle fleets, and we should consider the system balancing challenge as well.

At the case of hydrogen-driven fleets the first filling stations will be located near the depots. Since the demand is relatively low, hydrogen is likely to be produced on-site or shipped in liquid form on road trucks. When the demand for hydrogen reaches significant levels, pipelines from centralized plants may be built.

Nowadays the existing petrol filling station network is over-designed. There are too many stations alongside the road network would not be repeated with the prospective hydrogen stations.

The penetration of hydrogen vehicles could be successful if a significant fraction of public stations or spaces provide hydrogen fuel before consumers are comfortable purchasing hydrogen vehicles. The dilemma is perhaps more complex for hydrogen than other alternative fuels, due to the great uncertainty surrounding fuel cell vehicle

development, the multiple pathways by which hydrogen can be delivered to vehicles, and the diverse number of stakeholders that might be involved in early infrastructure development. Only after this infrastructure development point has been reached, and after consumers begin to embrace hydrogen vehicles, will the costs of these vehicles begin to drop as a result of mass production and learning.

Among end-use applications, hydrogen penetration will start with portable power, and then move to stationary distributed power, buses and government fleet vehicles. Later, hydrogen will fuel commercial and luxury passenger vehicles and finally ordinary passenger vehicles. (Agnolucci et al., 2007)

### 4.6. Improvements in the competition: better and cleaner gasoline vehicles

Car manufacturer companies are interested in constructing vehicles with improved fuel efficiency. There are no problems with the range of conventional petrol and gasoline powered cars, and the density of fuel station network sufficient. Alternative fuels, like bio diesel and alcohol offer more sustainable energy sources on the market. As conclusion we can say, that internal combustion engines will not disappear from the European roads in next decades.

## 5. LOGISTICS SOLUTIONS FOR SOLVING THE PROBLEM OF LIMITED RANGE

The man barrier of electric vehicle penetration is the limited range. It is still a question if the final solution is the hydrogen car or not. There are two different types of solutions for the problem from the logistics point of view: quick charging or on-board generation.

The BMW i3 car was designed for urban mobility. The 170-hp electric motor, which twists out up to 184 lb-ft of torque, receives its power from a 22-kWh, liquid-cooled lithium-ion battery. Thanks to the optional SAE DC Combo Fast Charging hardware, that battery can fill to 100 percent in about 30 minutes. The 220-volt Level 2 J1772 charger, meanwhile, takes care of business in about 3 hours. The motor works in concert with a single-speed transmission to send power to the rear wheels. The i3 uses regenerative braking to help keep the battery running as long as possible. In a research project, which involved 1000 participants and more than 12.5 million driven miles, BMW found that the average daily driving distance was around 30 miles (48 km). When viewed through that prism, the i3's 80 to 100 miles (129 to 161 km) of range looks more. BMW says that ECO MODE can add an extra 12 percent. In addition to the all-electric version, buyers can choose to equip the i3 with a 34-hp 650cc range-extending two-cylinder engine, essentially turning the car into a Volt-like series hybrid. That engine will not power the wheels but will serve strictly as a back-up power reserve, adding range and versatility (Weiss, 2013).

The B4H (box-for-hydrogen) concept is not a technical solution yet, but a special on-board storage and generation method based on the logistics viewpoint we are developing in the frame of our research (in Szabó-Szoba R&D Laboratory, Széchenyi University, Győr). The B4H concept offers to use hydrogen boxes as an on-board filling option in avoiding the hydrogen filling problem. These standardized hydrogen boxes can take place at any hydrogen-electric hybrid car working with fuel cell units. The electricity chain has lower energy losses, and the energy in the battery is excellent for V2G operation (normally there is no need for hydrogen). Users need the fuel cells only if they are travelling more like

usual (driving more, than 150km), to extend the range of the car. The B4H boxes are located in the car trunk and connected with the vehicle hydrogen tank. This box can accept two simple, isolated hydrogen barrels, each of them with 1 kilograms of hydrogen. With this quantity of hydrogen we can drive around 260 kilometres. These boxes and the filling mechanism are controlled by the on-board computer in the car which automates the process. Refuelling do not requires special filling infrastructure at the fuel station, because all the mechanisms are in-built around the hydrogen system of the car. The automated changing of empty tank starts with pushing the change button on the box, when the valve can close automatically. After ventilating and providing secure environment, the box ejects the empty tank. We should put the new 1kg hydrogen tank in the box and it will be automatically attach itself to the system. (The technical parameters of boxes require many innovative solutions we are searching for by using the TRIZ inventive principles. The prize of a box and hydrogen barrel seems to be high – the promise is that we can save a lot by mass production and by more flexible and simple distribution and refuelling cost).

This type of distributed storage and commerce – in the early phase of hydrogen vehicle penetration – is more suitable. Buying new hydrogen tanks is possible not only at the fuel stations, as users can buy it from offsite machines, and they can leave the empty tanks there as well. Finally, it would be much easier and faster to refill the hydrogen tank and continue the trip by using the B4H concept.

## 6. CONCLUSION

We will need to replace gasoline with a zero-carbon fuel. All AFV pathways require technology advances and strong government action to succeed. Hydrogen is the most challenging of all alternative fuels, particularly because of the enormous effort needed to change our existing gasoline infrastructure (Romm, 2006). In the same time, there are strong competitors on the market.

Based on our research we can say that V2G cooperation can contribute in green economy development efforts. Although, we should overcome the main short-term barrier, the problem of limited driving range the electric car concepts suffer by.

## 7. ACKNOWLEDGEMENT

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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# DEVELOPING SUPPLY CHAIN NETWORKS – STATUS AND TRENDS

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***Abstract***

Designing, establishing and functioning of supply chain networks are key issues of all participants in the supply chain and it must be viewed in the context of strategic, tactical and operational performance of individual participants. Development and functioning of all business systems takes place in conditions of increasing cost pressure, growing risks and market volatility, higher service requirements and stronger focus on sustainability. Business systems are therefore under constant pressure of making/changing strategic decisions that always involve setting and correction of strategic objectives and a multitude of analytical procedures that will support the decision. One of the strategic decisions of the growing importance that increasingly turns into a tactical decision-making is the construction of the supply network, or supply chains network. Formulation and implementation of supply chain networks and their optimal functioning depends on a number of internal and external factors that must be identified and measured and / or assessed in order to make sound decisions in the area close to the optimum.

The paper is based on previous theoretical knowledge and practical experience to explore criteria and optional performance for the design of supply chain network, and to present the context in which they develop. We proposed a contextual framework for SCN design and analsys that could help in revealing benefits and shortages of decisions made in SCN design and functionig. Using case study method, paper especially emphasizes trends of supply chain networks design for two groups of participants in the fast moving consumer goods area and ceramic industry area.

**Keywords**: suply chain network, network design, fast moving consumer goods, ceramic industry

## 1. INTRODUCTION

The contemporary business systems that work in terms of open markets and open competition are faced with different challenges like:.

- increasing cost pressure
- growing risks & market volatility
- higher service requirements
- stronger focus on sustainability (Francas, Simon, 2011)
- reduced time from design to realization of products and services on the market (time to market)
- reduced time from recognition of the need to it's fulfillment (response time)
- product variety
- technological progress in progress, distribution and communication
- new sources of relatively cheap labor, energy and raw materials
- the need for new management skills, etc.

Firms can hardly respond to these chalenges individualy and competition between firms turn in to compettion between supply chains to which firms belong.

In earlier periods of these phenomena, as responses to new demands, have appeared relatively simple supply chains – with linear horizontal structure, which was based on the mutual relations of raw materials suppliers, manufacturers, logistics systems, distribution channels, retail and the final consumers. These structures eventually evolved into more complex spatio-temporal structures which alter the number, the nature of relationships, activities, business objectives, capacity, information services and technology base of participants. Such complex structures represent what we now call the supply chain networks (SCN) or supply networks. Vitality of SCN is given by the common goals, interests, trust, reliability and shared risks. Viability of these structure seeks new organizational abilities as well as broaden modes and levels of management.

Since the time when the concept of supply chain management (SCM) was for the first time introduced to the business practices (Keith Oliver in 1982), SCM has evolved through several stages: creation, integration, and globalization, specialization phases one and two, and SCM 2.0. **(**Lavassani K., Kumar V. , 2009)

The evolution of supply chains in the SCN is supported by general globalization trends, primarily by opening a large number of huge global markets, by technological progress of all participants and by ways of how to establish and maintain relationships among participants. New entrants have also emerged in the supply and demand side of raw materials, goods, materials services, and informations.

In these evolutionary stages, terminology have been changed and supplemented many times, so today for virtually the same content, different terms are in the parallel use (SCN, supply networks, networks of supply chains, integrated supply chains).

Although we do not aspire to a definition that will encompass every aspect of the study area, we bring attention to sufficiently comprehensive definition of the term that indicates the nature of the problem and provides a clearer analytical approach in the research area. „A SC network is commonly defined as the integrated system encompassing raw material vendors, manufacturing and assembly plants, and distribution centres, to ensure solutions for effectively meeting customer requirements such as low costs, high product variety, quality and shorter lead times" (Gumus et all, according to Goetschalckx, & Shapiro, 2005 )

SCN are formed through different forms of horizontal and vertical cooperation, collaboration and integration, whereby key points of the network, as well as ways of connecting them (transport and communication) may belong to particular firms or to complex business systems - corporations. Optimization of such networks, although very complex, will probably be easier to achieve within unique corporate goals. Also, the

network performance is verified through the data in the available complex information systems, which integrate SCM as their modul or is itself a complex application tightly linked to the main and transactional databases of ERP. However, if other individual business systems (firms) also participate in networks, then it's relatively hard to come to the actual data on which networks operate and SCN management becomes complex.

Decision models used in SCN design and optimisation, describe SCN only in simplicity or only a few aspects of SCN design or operation.

Therefore, a lot of models of SCN that will be discussed in other chapters, even when they pretend to be an integral, describe real systems within only few aspects, with the partial goals and partial restrictions. Such models are useful for design of the initial structure or for checking some of the anticipated structure that may arise after the restructuring of the supply chains and networks, while in more complex systems, participants rely primarily on the experiences of good (or best) practice.

Below, the paper deals with the approach to the development of SCN, contextual framework for decision-making, a review of models and methods as well as with two examples of the development of supply networks in the ceramic tile industry and the food industry (mostly in fast moving consumer goods – FMCG – sector).

In the last chapter we try to assess the future trends of SCN based on broad sense of literature viewed and cases studied.

## 2. SUPPLY CHAIN NETWORKS DESIGN APPROACH

Changes in supply chains occur equally in the upstream and downstream flows, thus the complexity of the issues and relations between raw material suppliers, manufacturers, distribution centers, logistics, retail channels and the final consumers is increasing.

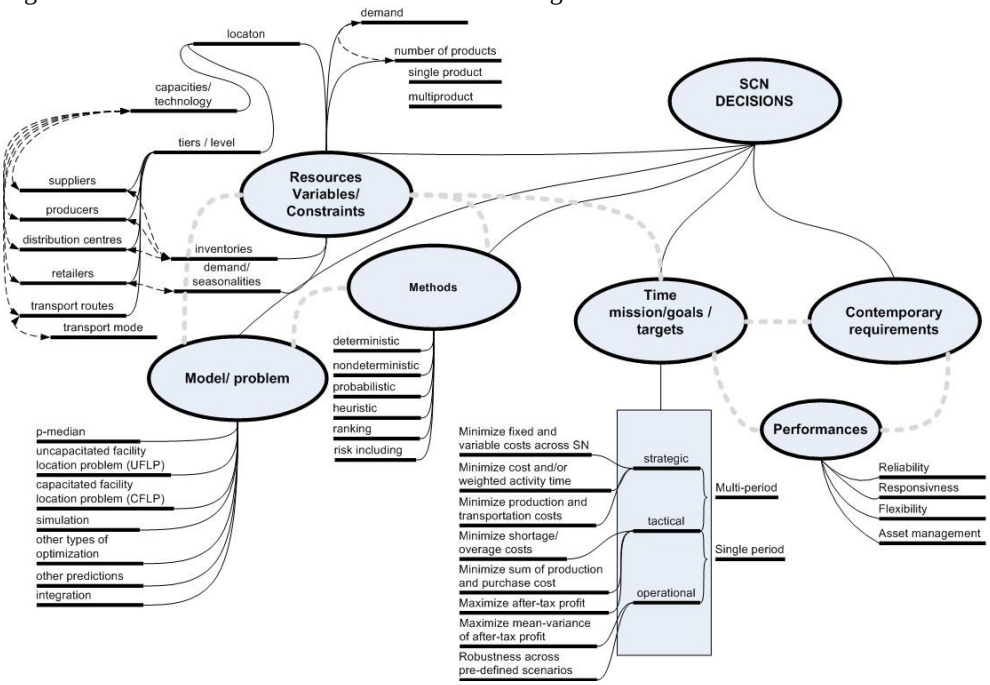
„A supply chain network design problem comprises the decisions regarding the number and location of production facilities, the amount of capacity at each facility, the assignment of each market region to one or more locations, and supplier selection for sub-assemblies, components and materials" (Chopra and Meindl, 2004) Chopra, S., Meindl, P., 2004. Supply Chain Management: Strategy, Planning and Operations, second ed. Prentice Hall, Upper Saddle River, NJ..

Decision problem in SCN design and functioning should be viewed in broaden context that comprises

- contemporary requirements of stakeholders (business units) in SCN
- mission and time horizons of goals (objectives ) and their aligning
- resources, variables, constraints (impediments) for the goals acheivement (tiers – levels of participant, location, capacities, products, demand…)
- nature of problem that should be solved in SCN and choice of model that best describe decission situation
- choice of method and technique used in model solving
- key performance indicators of SCN success.

Contextual framework for decision-makers in the design and functioning of the SCN is shown in Figure 1.

Figure 1. Contextual framework for decision making about SCN




Source: authors

Taking it dinamicly the framework should be used iteratively as follows: decision makers recognize some contemporary requirement or new goals (objectives) are settled. Decision makers turn their focus on resources, variables and constraints, deciding of model problem and method suitable for model solving. Solution are followed in changings of key performance of particular participant and network as a whole.

In practical terms, design of SCN requires answers on several key issues

- What (Planning Horizons, Target Issues, Modeling Targets Validity of Integrated Logistics)Why (Contemporary Requirements, Impediments
- How (following practical steps to success, analysing best and worst practices) (Karrenbauer, 2005.)

But also, because of everything that SCN design in itself still bears, („substantial geographical distances, increased transportation costs, increased lead-time in the supply chain, different local cultures, languages, and practices) (Dornier et all., 1998; Wood et all., 2002; MacCarthy and Atthirawong, 2003) there is a need to ask two other questions:

- Who
  - Managers with new management knowledge and skills and ability to make decisions in a complex set of objectives, decision variables and constraints.
  - Managers responsible for the strategic orientation of the business systems that are aware of the width and length of supply networks
  - Managers who are responsible for the tactical level (among SC managers)
  - Operational managers of business processes
- When

- Before the operating system set up their business processes and formal organizational components in the network of supply chains
- After restructuring
- After a merger or acquisition
- Before or after the introduction of a third party logistics (3PL).

Due to the limitations of this paper, in next subchapters we shall discuss problems of goals setting and models selection in SCN design and optimisation.

### 2.1. The objectives of design and operation of supply networks

The goals of SCN design should be considered int he context of acheivements and time horizons for particular achievement.

When talking about goals of design of the distribution or supply network, it is necessary to point out that through this form of strategic planning economic operator wants to maximize the economic effects over a longer period of time (Goetschalckx & Fleischmann, 2005, p. 117) and also present the consequences of strategic decisions on tactical activities such as the optimization of transport (Brandimarte & Zotteri, 2007, str. 54). Therefore, the goal of optimizing the design of the supply or distribution network is to minimize the total cost of holding inventory, warehouse costs and transportation costs, while satisfying customer demand related to delivery time. At the same time we can say that the network is optimized with the least number of distribution facilities that will meet the customer's response time (Frazelle, 2002, p. 188).

All operating business systems realize its basic goal - the survival and viability - through three objectives derived: growth, efficiency and flexibility, respectively ability to adapt. Designing networks of supply chains will always serve to these general and derived objectives of the participants in the supply network.

The growth of the business system is reflected in the growth of market share (sales) and appreciation of the business system, and network design (capacity, location, number of individual participants on some level) will directly affect the derived target.

Flexibility is, in general, the ability of a business system to relatively quickly and with the lowest possible cost adjust to new situations that can have various causes. This ability must be incorporated into the business system and its relation to the environment and is a key objective in the survival of business system. „Initially an appropriate network design is needed to control efficiently all the elements in all stages, to be flexible against the changing situations, to provide coordination along the supply chain, and so be successful in SCM which is very complicated (Cakravastia et al., 2002; Graves & Willems, 2005). However, once created, the network of supply chains should, because of the relatively high cost, work for a long time, which implies its stability. The problem of these conflicting requirements (stability vs. flexibility) is solved by construction of multiple periodic scenarios in which the uncertainty of future scenarios introduce probability judgments, and stochastic processes.

Considering the time horizons of SCN design participants are faced with alignment of strategic, tactical and operating goals.

Main strategic goal of SCN design are: optimal size, number and location of facilities, mergers and aquisitions, regional demand planning, identification of key competitors and their plans, infrastructure factors, tariffs and taxes, political excange rates and demand risk, economic climate (Karennbauer, 2005)

Key tactical goals of SCN design are comprised of production planning, transport optimization, inventory optimization, uncertainty and business dynamics, working capital, changing in network topology (Francas, 2011).Problems related to operational targets of SCN design comprise product scheduling, shipment/dispatching, replenishment and SC information development as well as technologies that enable processes across the supply chain net.

Problem of alignment of goals and targets stem from dynamic of many factors that are associated with SCN design and operatian like are: customer demand, new product introduction, existing product deletions, freight cost changes, facility status changes, raw material sourcing changes, manufacturing technology upgrades (Karenbauer, 2005).

### 2.2. Models and methods in SCN design and optimization

SCNs are complex structures that are designed and operate in equally complex environments. When confronted with the description of such structures, either in the analysis, design or operation, it is necessary to choose a model which will in the best way describe the aspect of reality that is modeled - in terms of choice of objectives, choice of variables, constraints and the (initial) parameters, speed of reaching solutions, familiarity with how to think the decision-maker, etc. In addition, SCM is the management of business systems that are in mutual interactions.

Operating business systems can use a variety of models and methods for forming SCN. In principle, the models can be divided into: a) general models of SCM that contain specialized modules for the design and optimization of the SCN (usually developed and owned by specialized SCM organizations); and b) particular models whose primary purpose is optimization of the SCN.

#### *2.2.1. Models and methods of professional SCM organization*

In this group may be particularly specified frequent four SCM models. Probably the most common and widely used SCM model is the SCOR model, which is owned by SC Council. SCOR model is based on three pillars SCM: process modeling pillar, performance measurements pillar and best-practices pillar ( http://supply-chain.org/scor.)

SCM Framework model, developed by SCM Institute (Sarasota, Florida, http://www.scm-institute.org/), is mostly recognized because of it's emphasized process orientation (based on integrating and managing business proceses across the supply chain).

Supply Chain Best Practices Framework originated in SC Consortium «provides an integrated structure for defining, measuring and improving supply chain processes“ (http://www.supplychainconsortium.com/Framework/ )

American Productivity & Quality Center One (APQC) also developed SCM process oriented model called APQC that represents „ a taxonomy of cross-functional business processes intended to allow the objective comparison of organizational performance within and among organizations … as an open standard to facilitate improvement through process management and benchmarking, regardless of industry, size, or location“ (http://www.apqc.org/knowledgebase/download/268712/K03785_PCF_Cross%20Industry_v6_July2012.pdf)

*2.2.2. Design and optimization of SCN models*

Models and methods of solving them are chosen depending on which target function, which restrictions and conditions, as well as initial decision-making variables are selected. For example „in a discrete facility location problem, the selection of the sites where new facilities are to be established is restricted to a finite set of available candidate locations. The simplest setting of such a problem is the one in which p facilities are to be selected to minimize the total (weighted) distances or costs for supplying customer demands. This is the so-called p-median problem (Melo et all, 2008, Nagurney, 2010).

Models for the design of distribution networks are very complex models whose complexity stems from the great diversity and high uncertainty of input data (a large number and variety of participants in the system, a long planning horizon and a large variety of possible distribution systems and strategy (Patel, 2009). Some of the better known models in the design of the distribution or supply network are K-media model, location-allocation model, problem of warehouse location, etc., and mainly come from the engineering disciplines (Goetschalckx, 2009)[1].

## 3. CASE STUDIES

Using the proposed contextual framework, we should try to reconstuct creation and operation of SCNs in two different industrial scopes. The first one is cheramic tile industry and the second one is food industry (below the fast moving consumer goods industry), Choice of these two sectors results from authors familiarity and experiences with this industries and relevance of SCN design that these industries are faced with.

Results of our analysis reveal different dynamic and different kind of problems that these two industries has in SCN design and functioning.

### 3.1. Tiles industries

Tile industry or ceramic industry generally occurs near the source – opencast minings with special requirements - mixture of mineral resources (raw materials) with the necessity of energy infrastructure and water. The raw material is relatively inexpensive and does not tolerate high transportation costs. Development of ceramic products manufacturers was followed by development of the technology for their production, design, industry of additives for the production (frit, paint, glazing materials, printing) and industry of materials and tools for their installation. Ceramics market, like most others, a relatively long time had a local, then national and then only in the second half of the 20th century strong international character.

Apart from the manufacturer, main members of ceramic tiles supply chains or networks are retailers, wholesalers, and carriers.

There are basically two groups of retailers:

- Highly specialized retailers - which in its assortment primarily offer ceramic tiles, but also materials for their installation, aids and materials for design of space in

[1] In the same source, it is possible to see the most common types of input data for such model, based on which then calculates the number and arrangement of facilities, and other parameters of the distribution system

which the tiles are installed (sanitary ware, bathroom and kitchen furniture, taps, heating equipment).

- Wide specialized stores/retailers - shopping centers with materials and equipment for construction (BAUMAX, OBI,...), with developed logistics distribution centers (LDC)

On the other hand, there is relatively small number of stores that operate exclusively as a wholesaler in ceramic tiles industry - usually have a combination with the retail. LDC's are usually organized by retailers at the regional level or by independent participants who offer their services to manufacturers (eg Sasuolo) where shipments are collected and sent to customers.

In the ceramic industry, carriers are usually independent companies that operate as a third part logistics (3PL). If companies have their own distribution centers, they also organize part of retail supply through their own fleet.

World ceramic industry, or more precisely the ceramic tile industry, has experienced enormous changes in the last 15 years. Leaders of the world's production originating from Italy and Spain have got new competitors in the world market originating from China, India, the Middle East, Turkey, Russia, Ukraine, Brazil. Leadership of Spanish and especially Italian producers is reflected today primarily in the technological progress in the production and design, and in export mainly to developed markets, while producers from India, China, the Middle East and other are predominantly facing their own market which has seen the boom in construction and less developed world markets with lower purchasing power. Below will be given forms of integration in supply chain of ceramic tiles (see Table 1) as well as the key processes that lead to changes in supply chains and design of supply networks in the ceramic tile industry.

Table 1. Forms of integration in supply chains of ceramic tiles industry

| **Horizontal integration** |
|---|
| manufacturers of products for similar purposes |
| manufacturers of floor and wall coverings (textile floor coverings, rugs, ceramic tile, stone, wood, laminate and vinyl coverings, wall coverings - Example: The Mohawk Group source .....) |
| manufacturers of complementary products for interior spaces |
| manufacturer of ceramic tiles and sanitary ware, bathroom furniture and taps manufacturer (eg Roca) |
| combination of the same purposes and complementary products (flooring and complementary products - sanitary, furniture; eg Porcelanosa) |
| ceramics manufacturers and producers of construction materials (aluminum cladding and other metal products). |
| **Vertical integration** |
| raw material manufacturers (opencast mining of clays and related materials) and manufacturers of ceramic tiles |
| ceramic tiles manufacturers and design and architectural house |
| tile manufacturers and manufacturers of technology for the production (conveyors, mixers, presses, glazing, furnaces, packaging lines, know how) |

Source: authors

Vertical integrations with wholesale and retail trade, as a form of corporate vertical marketing, are rare. Manufacturers usually take support in furnishing facilities of retail, education and designing, as well as in providing information about production plans and stock. This way they also achieve vertical marketing in supply chain, but in contractual or administered forms.

SCN's in the ceramic industry have simpler forms and rarely include vertical integration. For example, a consortium of manufactures can control mines of raw materials, but the vertical integration occurs less frequently in the downstream flows. Downstream integration is possible at the level of distribution centers (the case of the Ukrainian manufacturer who controls clay mines and takes control of the three distribution centers - Russia, Ukraine and Central Eastern Europe).

Also horizontal integration is achieved between tile manufacturers and smaller producers of decor and complementary products (manufacturers of facade construction).

Another type of integration takes place in the mergers and acquisitions of manufacturers of alternative products such as floor coverings, eg. Mohawk industries where integration is achieved in the production and especially in products for coating the floor surface (textile floor coverings, rugs, ceramic tile, stone, wood, laminate and vinyl trim).

Possible integration for appearance on third markets are the integration of technology producers and manufacturers of ceramics (Sasuolo clusters tile and technology manufacturers for onset on third markets - China).

In Italy, manufacturers form consortiums that combine groups of manufacturers who are related to technology manufacturers and often perform together on third markets. It is not just about production technologies but also technologies for environmental protection, and designs. Also the integration occurs among the suppliers which supply their customers with frits, glazes, colours, red lead, grinding media, zircon opacifiers for ceramics, wear-resistant and high mechanical performance technical ceramics.

### 3.2. Fast moving consumers goods SCN

The second case belongs to food industry and has much more dynamic development. Taking relatively short time period of hystorical data, we will present how SCN has been developed in upstream and downstream tiers of SC thus forming complex SCN comprising mostly participants that belongs to one corporation.

Case that was researched in this field comprises stakeholders of SCN that belong to the largest food and agricultural corporation in Croatia. For the purpose oft his paper production of drinking water and related products (juices) was investigated in downstream of SC and also development of retail net and its connection with other stakeholders (including water producer) in upstream of supply chains

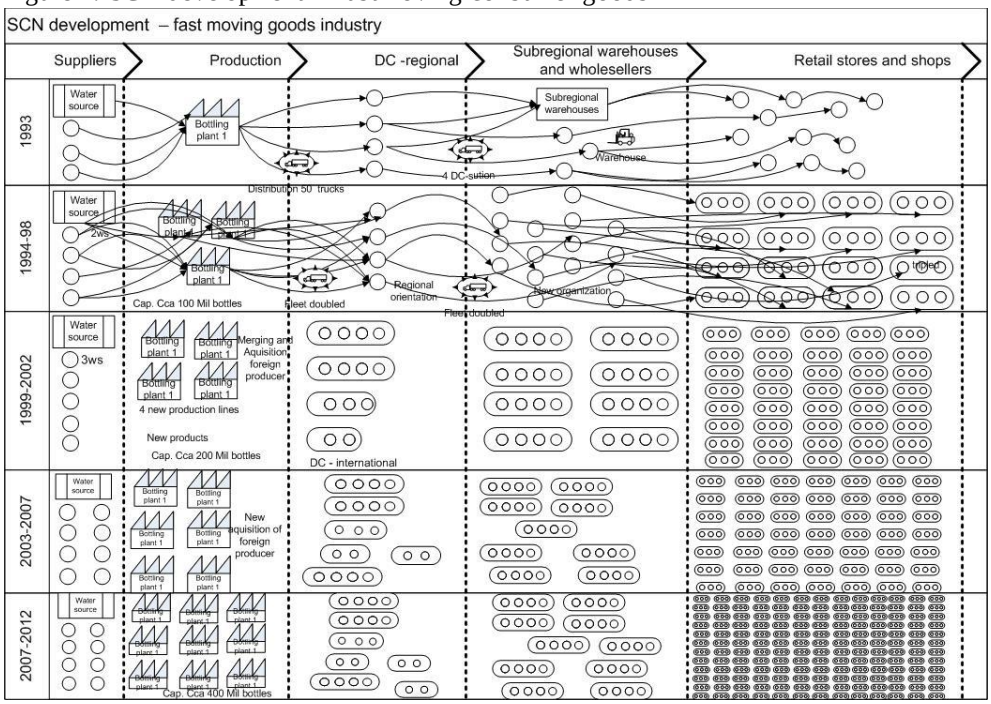
Analysis has showed that during 20 year period time todays SCN has been developed through:

- capacity enlargement of water sources
- production (bottling plants) capacities englargement
- new product introduction
- own production of packaging
- transportation outsourcing
- reorganization and capacities enlargement of regional distribution centers
- entrance on international markets
- better utilization of new LDC-s

- acquisition of foreign producers
- exponential growth of consumers
- exponential growth of wholesale and retailing capacities
- mergers and aqusition of corporation that already have developed their SCN
- new software and hardware support for SCM activities.

Historical development of SCN of water production and develeopment of other nodes in SCN is presented in figure 2.

Figure 2. SCN development in fast moving consumer goods




Source: authors

The first phase is characterized with typical investment problem in capacity enlargement (production tier) with its objectives and constraints. The scond problem was problem with capacities of transport fleet, Also the capacities of regional warehouses and distribution centers as welas capacities of wholesellers. Small number of owned retail stores and shops was problem that has been investigated.The second phase was also characterized with investments problem and capacity determination in production tiers, by reorganization of regional distribution centers and microdistribution. This phase also include high investments in retail capacities. These problems fall under the location/allocation problem and problems of optimal capacities as well as optimal inventories problem. All of these problems also falls in asset management problem.

In third phase problem of introduction of new production line arised and also new suppliers involvment. One big merger and aquisition has happend that required complex business analysis, huge investment and reorganization in all tiers of SCN. This phase is characterized by enlargement of fleet and new information technology introduction.

The fourth phase is characterized mostly by problem of optimization of SCN, new suppliers introduction and capacities enlargememt, especialy on retails tier.

In fifth phase new huge investments are made in production tier, the biggest LDC on new loaction, extension and expansion of retail tier (retail shops, superstores, megastores). Problems in this phase encompasses all typea of problems mentioned in our framework and also different kind of goals, objectives, with complex system of variables, constraints and solutions (location problems, problem of optimal capacities in all tiers, variable multiproduct demand, minimizing fixed and variable costs, profit maximization or specifici targets of predefined scenarios.

We don't have information how the decisions have been made in this very dynamic development of whole SCN where most participants belongs to one huge corporation. Having this information, we could verify validity of our framework and models used in decision making. This could reveal good and bad practices and help to enrich practice of SCN design.

## 4. CONCLUSION

Supply chain networks in particular industrial sector should be designed with respecting of all specifities that particular sector has (raw material properties, production processes characteristics, logistic systems support, final products properties and their prices, distribution channel, demand attributes etc.). Despite the specifities of SC or SCN in particular industry, some key characteristics of SC(N) remain the same for most of SCN-s and some will need to re-evaluate their current processes and performance with these key trends in mind (Hitachi, 2009):

- Demand planning as an imperative
- Globalization
- Increased competition and price pressures
- Outsourcing
- Shortened and more complex product life cycles.

Similar postures can be found in (Gumus et all, 2009) „Current factors affecting design and changes in contemporary SCN are: increasingly domestic and global outsourcing, integration of sourcing decisions across tiers in the supply chain and broadened definition of supply chain performance, as mission, strategy and objectives **(**Meixell, Gargeya, 2005).

Proposed framework for SCN design enabled us with better insights in SCN and reveliation of main relation of SCN stakeholders, their goals, missions, type of problems (models) that have to be solved and drivers of SC dynamics of particular sector.

SCN in cheramic industry, which highly depends on civil construction sector and seasonality on one side and necessity of continuous production on the other, is forcefully oriented on global market. Cheramic tile market is characterized by highly capacitated newcomers with low price products. Nodes of SCN of this industry are individual firms and integration normaly occures in relatons of material resourceres and production on upstream level and wholesellers and retailers in downstream of supply chain. Logistic (transportation and intemediate warehousing) come from 3th parties. There is no chain whose all members belong to one corporation. Main problems in SCN design in this industry is problem of optimal capacity of producers, close connections with retailers

Supply chains in fast-moving consumer goods (preferably food products), due to the nature of their products, do not pretend to be global but mostly regionaly oriented SC or SCN. Demand mechanism in this sector is well explored. This industry is characterized by competition of supply chains and firm colaboration is basis of their viability. Integration and collaboration oftenly ended in formation of corporation.

Common goals, planning and strategies are more effective, capacity utilization is better and whole effectiveness of this networks is higher.

SCN management, regardless of industrial sector to whom net belongs, in near future should be „ integrated, customercentric, distributed; having interoperability, scalability; with open and flexible infrastructure; autonomous, capable of self-organization and reconfiguration, coordination and negotiation; with optimization and learning mechanism so evolve in and adapt to the dynamic marketplaces; synchronized and agile (to handle rapid change); involving production planning and scheduling; capable of making forecasts accurately; both active and proactive; compatible with globalized manufacturing; seamlessly integratable with E-commerce and M-commerce; and proper performance-measurements“ (Misra et all , 2010).

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# II. DISTRIBUTION AND LOCATION PROBLEMS

# NEW RETAIL BUSINESS UNITS' FORMS IN VALUE CHAINS

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***Abstract***

The formal features of a retail business unit are subject to permanent changes. Starting from the detected regularities therein, this paper's objective is to enrich an informational basis for a detection of new, more adequate forms.

The paper initially analyzes the formal features of retail business units and their changeability. Furthermore, it also specially emphasizes the changeability of environmental factors pertaining to a retail business unit (market and competition technology, institutional conditions, and the like). The meaning of retail business units' form is discussed from the point of view of certain companies and/or economic activities, as well as from the point of view of an overall economy in certain country. Namely, the forms of retail business units, integrated in value chains, exert a significant influence on overall economic trends in the aforesaid country.

Thus, a responsibility for retail business units' formation is born not only by the retailing companies but also by the institutional factors.

In the Republic of Croatia (as well as in most transitional countries), the problems in the formation of retail business units are quantitatively observed in a discrepancy between sale areas and a level of overall economic development, as well as in an unsatisfactory retail structure (concerning the forms of retail business units) and an unsatisfactory level of vertical interconnection between retail business units.

**Keywords:** retail business unit's form, value chain, retailing concentration, business internationalization, business globalization

## 1. INTRODUCTION

Based upon an accessible literature, the paper initially analyzes the features of a business unit's form (type) while emphasizing its changeability, conditioned by the changeability of environmental factors.

Subsequently analyzed is the creation of new forms of retail business units in a retail company's strategy. Separately analyzed is a value chain concept and a diffusion of successful forms of retail business units from one country to the other in contemporary retail internationalization processes. Namely, thus are the international value chains being formed, which have a major influence on an individualized national economy, since a competition of entire chains is being developed.

The economy of the Republic of Croatia is taken as an example demonstrating the importance of new retail business units' forms. Based upon analyses conducted, the

problems of development of retail business units' forms are being emphasized quantitatively (capacity) and qualitatively (retail structure pursuant to the retail business units' forms and their vertical interconnection in value chains).

## 2. CHANGEABILITY OF RETAIL BUSINESS UNIT'S FEATURES

Since retail is developed in various phenomenal forms, important is the notion of a "retail business unit's form" as to encompass multiple categorization features.

In German literature, widespread is the expression of an "enterprise" (German *Betrieb*), signifying one or more retail business units of the same type pertaining to a company.[2] That could correspond to the features of a "strategic business unit" (e.g., the one consisting of one or more company stores of the same type).

A phenomenal image created upon a market (marketing) strategy could be opined of as the form of a retail business unit. Similar business units could be grouped (cf. Müller-Hagedorn, 2005, p. 81).

Actually, the expression "retail business unit form" could denote a general combination of "merchandise/service" pertaining to the retail strategic business units and being relevant to more than one company; however, if it is concretized to a single company, one may speak of a "strategic business unit type" (cf. Ahlert and Kenning, 2007, p. 111).

The following can be assumed as the most frequent criteria for systematization of business unit types in retailing (cf. *Betriebstypen des Handels*, 2013): (a) assortment strategy, (b) strategic business unit size, (c) service principle, (d) payment type (merchandise transition), (e) distance conquest (purchase upon arrival and merchandise-oriented cash-and-carry and/or a purchase implying a delivered merchandise receipt), (f) price strategy, (g) purchaser cycle, (h) agglomerative integration (location strategy) (i) integration (legal binding).

Similar to this notion is the one of a "retail format." Nonetheless, the "retail format" pertains more to the retail mix variables (see Fernie et al., 2003, p. 128; Dunne and Lusch, 2008, p. 53; Hasty and Reardon, 1997, p. 255), less to an integration in the sense of a vertical retail business unit's interconnection.

The adduced features of a retail business unit form are very changeable. In that sense, we have emphasized the importance of a permanent concentration development (which is connected to the development of internationalization and business globalization) and an increase in market transparency enabled by ICTs (Segetlija, 2011a). Furthermore, the new business concepts, e.g., the ones within an "efficient consumer response" (ECR), provide for a new quality to certain marketing variables in retail business units due to cooperation between retail, productional, and other companies within an overall value chain (Segetlija, 2009). Retail is actually observed as a value chain constituent (Segetlija, 2010), and contemporary technologies also facilitate the creation of new retail business unit forms.

A speciality in retail business units' formation lies in the creation of an environment by legislative and administrative organs (especially pertaining to zoning and lot allocation). Thus, the so-called "specialized marketplace" in Germany (German *Fachmarkt*) was also partially created as a reaction to the new post-1977 construction legislation (Blotevogel, 2003). Subsequent to the municipal and regional obtainance of an effective instrument for

[2] Cf. there about: Behrens, K. Chr: Standortbestimmungslehre, Band I, Ed. K. Ch. Behrens, Köln – Opladen, 1961, p. 40, qtd. in Rupmann , 1968, p. 17.

the management of a large-sized retail development and the beginning of its restrictive deployment, investors partially reacted while separating the self-service department stores in stores having a single commercial vocation, i.e., while expanding the principle of a "consumer marketplace" (German *Verbrauchermarkt*)[3] to the commercial vocations in the non-foodstuff domain, mostly pursuant to a discount principle. Additionally, specialized marketplaces are being increasingly widespread within the "wild" shopping centers while offering a part of the assortment essential to the municipal downtown areas.

Therefore, the forms of retail business units should be observed as constituents of a retail company (in a horizontal concentration sense), i.e., as a mall constituents (in the sense of spatial concentration), but also as value (supply) chain constituents in a vertical sense. One should consequently take environmental changeability (due to a market and competition effect, new technology, institutional conditions, legislation, zoning, economic policy measures, infrastructural investment incentives and the like) into account while analyzing the development of certain forms of retail business units.

## 3. CREATION OF NEW RETAIL BUSINESS UNITS' TYPES

Starting from a supposition that retail companies develop certain types of their business units as to gain competitive advantages, we will mention that the following is nowadays taken into account as the approaches for a selection of main orientation in a retail company strategy (Müller-Hagedorn, 2005, pp. 38 – 49): (a) generic Porter's strategies, (b) Ansoff's matrix, (c) Abell's scheme, (d) value chain creation concept.

The following is significant in Porter's strategies: (a) cost-oriented leadership strategy (demarcated as a "discount strategy" in commerce), (b) differentiation strategy (offer of a stronger service), and (c) segmentation strategy (orientation to market segments).

The application of the Ansoff matrix as the main retailer orientation relates to the following (a) market penetration, whereby the purchaser segments may be the same and/or different on the same markets or on the expanded markets (regional, international), (b) product development (merchandiseassortment), (c) service and business unit type development, (d) diversification with new services on the same and/or expanded markets.

The Abell scheme pertains to a 3D depiction wherein the following is taken into account when selecting a retailer orientation: customer groups (segments), categories of needs (regarding functions, i.e., assortment and services), and new technologies (market contacts and all other business processes).

A value chain creation concept is important due to the fact that competitive advantages can actually be created out of multiple partial activities (value-creative activities), e.g., supply, logistics, or informatics.

Each retail company also starts from the selection of its specific "value chain" while creating a strategy of its own (Müller-Hagedorn, 2005, pp. 46 – 49).

In that sense one should observe his/her organizational structure and flows and processes of a company. For a definition of a value chain within a company, one should firstly analyze its primary and then its ancillary activities. Further analyzed is a position of the aforesaid retail company within an overall value chain in a strategic orientation heretofore. Essential is a high-quality analysis (a quality estimation of individual value

[3] A consumer marketplace (German *Verbrauchermarkt*) and a self-service department store (German *Selbstbedienungswarenhaus*) represent German specifics and are mostly similar to the hypermarkets.

chain members, e.g., collaborational capacity, punctuality, and the like) or a quantitative analysis (a relative share of certain value chain activities within an overall consumption of resources, i.e., in an overall corporate value creation).

Naturally, in that respect one should also reconstruct the structure of a competitor's value chain. The conclusions on what proper value-creative activities could elevate a company above its competition should be derived based upon such an analysis.

In any case, significant is this step of searching and assuring proper permanent competitive advantages. While comparing with competitors and their value-creative modalities in (internal and external) value chains, one may discover proper advantages and disadvantages.

In a cost-oriented advantage strategy, first is the behavior of costs related to certain value-creative activities, while the characteristics of effects and services are something that differentiates a company from its competition. According to a basic strategy, here from result different meanings and forms of certain activities within a value chain.

For a success in search for competitive advantages, decisive is to harmonize a proper value chain of an observed company with receiver's demands. Of course, one should recognize the decisive customer criteria when purchasing and their ranking in a defined market area. A value chain should be adjusted to certain purchasing criteria (e.g., as an objective to achieve low prices). This adjustment is subsequently formulated within a strategy in the sense of certain activity harmonization in an in-company value chain, as well as with the companies "upstream" (merchandise and service suppliers). In that aspect, a proper market position of a retail company can be enforced via strategic cooperation and alliances, as special features of its retain business unit types.

The development of new retail business unit types pertains to two basic forms (Ahlert and Kenning, 2007, pp. 137f): (a) innovations, (b) imitations.

In innovations, we speak of the development of completely new combinations between merchandise and service factors, while the new forms of retail business units based upon successful predecessors and an excellent benchmarking are essential for an imitation. This phenomenon is correlated with retail internationalization and the so-called "diffusion processes" (see Segetlija, 2012c, pp. 105 – 107). Innovations can be proactive (management of a retail company develops new concepts without an external pressure) or reactive (a new type of retail business unit is being created as a reaction to a changing environment, e.g., due to the development of new technologies).

This diffusion phenomenon regarding successful forms of retail business units from one country into the other is especially significant in contemporary retail internationalization processes, for that is how international value chains are formed, exerting a major influence on an individual national economy since an overall chain competition is being developed.

According to the adduced authors, various methods for the development of new retail business unit types are placed at our disposal (but they most frequently have a mere heuristic importance). One of the simplest could consist of connecting the known forms of retail business units with the new assortment areas, whereby the ideas for new combinations could be obtained.

## 4. CERTAIN REMARKS ON PROBLEMS PERTAINING TO THE FORMATION OF RETAIL BUSINESS UNITS IN THE REPUBLIC OF CROATIA

Since the retail business unit forms can be observed from the point of view of economic functions executed thereby, from the point of view of marketing instruments combined in a strategic management of a retail company, as well as from the point of view concerning a combination of business process factors activated therein (Lerchenmüller, 2003, p. 248), its significance can be observed both from the point of view of individual companies and/or economic activities and from the point of view of an overall economy in certain state.

In that aspect, one should emphasize that an alteration of functions does not only mean an encompassment of retail economization procedures, but a process of exclusion pertaining to certain forms of retail business units is also ensuing there from (Barth et al., 2002, p. 33). In a retail business unit, investment in marketing instruments is connected to an investment in the labor process factors (e.g., a merchandise assortment, as a marketing variable, is connected to the amount of stocks as a logistic element).

The analyses for the Republic of Croatia have especially detected the following:

(a) a disproportion between the level of general economic development and that of retail capacities;

(b) inadequate structure in the sense of modern retail business unit forms (an exaggerated share of small-sized stores, lack of discount stores, insufficient multichannel retailing, insufficient vertical interconnection).

Analyses conducted in the grocery sector have demonstrated that a discrepancy between the level of general economic development and that of retail capacities may (quantitatively) result in a weaker retail efficacy. Namely, due to a rapid increase in sale areas in the Republic of Croatia, disproportions have been manifested regarding an overall economic development level, as well as in most transitional countries (Segetlija, 2012d). This overemphasized development of sale areas is greatly conditioned by the erection of suburban malls (Segetlija, 2011b).

A diminished efficacy of retailing in the Republic of Croatia has been manifested especially in large-area stores, e.g., hypermarkets, whereby a pronouncedly lower sale area productivity than that in FR Germany was realized in 2009 (Segetlija, 2012b).

Qualitatively, a retail structure pursuant to the business unit forms has been significantly changed in the Republic of Croatia with regard to that some 20-odd years ago, but a quality enjoyed by the market-developed countries has not been reached yet: a share of small-sized stores is relatively high, and the Internet-based, i.e., a multichannel retail, is slightly less developed (Segetlija, 2012b, p. 106; idem, 2012d).

An over-proportional development of retail capacities in certain transitional countries is a result of weak retail efficacy in GDP creation, so we may conclude that such a retailing development does not significantly contribute to their overall economic development (Segetlija, 2012d), i.e., that the forms of their retail business units are not sufficiently vertically interconnected.

Value chains end on their retail markets, pertaining to the following: (a) domestic producers and retailers, (b) foreign producers and domestic retailers, (c) foreign producers and foreign retailers, (d) domestic producers and foreign retailers.

While analyzing a distributive trade within the structure of Croatian economy, it has been established that the retailing importers (cases (b) and (c)) evicted domestic production

from their value chains (e.g., in foodstuff sector) due to favorable prices abroad, having thus elevated a negative foreign trade balance (Segetlija, 2011c, p. 462; idem, 2012a, p. 57).

Furthermore, a degree of retail concentration in the Republic of Croatia does not provide for a developmental potential as in other market-developed countries because the market is significantly smaller. In that sense, the largest retail chain in the Republic of Croatia cannot be competitive to international retail chains widespread in several countries, based on its economy of scale. Therefore, their types of retail business units also have other quality of execution regarding marketing and logistic functions (concerning their size and external organization, group affiliation, and value chain management).

In that respect, we may emphasize that only two out of five leading retail chains in grocery sector implement central distribution as a predominant distribution type and use the so-called "cross-docking," according to a 2011 research (Dujak, 2012, p. 271).

For these reasons, the tasks pertaining to the development of new, more rational forms of retail business units, and new business models could be posted before the retail economic entities in the Republic of Croatia in the observed sector, based both on further horizontal connection between economic entities in this activity (with a possible international expansion) and on a vertical connection to the producers and consumers (Segetlija, 2012b, p. 109).

## 5. CONCLUSION

By virtue of a concentration process development, retailing in a value chain becomes dominant, especially in a grocery sector, whereby a high integration degree in value chains becomes a significant characteristic of a retail business unit type.

The features of retail business unit forms are being changed due to the changes in environmental factors. The environmental factors are modified based on the development of technology, market relations, and institutional factors in the sense of economic and social life regulation.

Analyzing the forms of retail business unit types in the Republic of Croatia as well as in other transitional countries, one could establish that their capacities and their structure are inadequate to the level of general economic development. Unobserved is a possible influence and responsibility of institutional factors upon a harmonious economic development.

In that respect, we may raise a question whether an insufficient size-based efficacy can be substituted in the observed transitional and other economically weaker countries while more rapidly introducing technological innovations and interconnecting it vertically.

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# MEASURING THE INVENTORY TURNOVER IN DISTRIBUTIVE TRADE

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***Abstract***

The ability of rapid inventory turnover indicates the success of a company in the use of their investments in inventory as a major business asset of the trading company. The inventory turnover expresses the speed at which the trading company sells its inventories or how much turnover the average inventory generates in one year. Also, the inventory turnover indicates how many times during a year the trading company is able to sell the amount of merchandise that matches its average inventory. The inventory turnover reflects how frequently a company flushes inventory from its system within a year. The inventory turnover greater than one indicates that the average inventory is sold in less than one year or it generates more than one turnover in a year.

The inventory turnover can be calculated in two ways: as the ratio of the cost of goods sold for the reporting period and the average amount of inventory for that time period or by dividing sales revenue for the reporting period by the average amount of inventory for that time period. Furthermore, these ratios of inventory turnover have different meanings for different trading firms. Therefore, the authors of this paper will explore how these ratios affect the success of the trading companies. It will be investigated whether replacing one ratio with another ratio affects the interpretation of the success of the trading companies. Moreover, the relationship between these two ratios and the rate of return called the return on assets (ROA) will be investigated. Trading companies are divided according to the

criterion of their size (large, medium-sized and small) and according to the criterion of the type of merchandise they sell (specialized and general consumer goods).

The study included 28 large trading companies, 30 medium-sized trading companies and 22 small trading companies, which altogether make a total of 80 companies from the Republic of Croatia. The data used in the study are based on the financial and accounting indicators for the year 2008 and the year 2009.

**Keywords:** inventory turnover, profitable inventory management, trading companies.

## 1. INTRODUCTION

The return on assets is typically measured as the ratio between the net profit and the total assets of the company. However, it can be measured as the ratio between the gross profit (margin) and the total assets of the company. In this case, the company's success from selling inventory and the value of the return on assets depend on a combination of two factors (Edmonds, 2000, p. 379): the gross profit rate (gross margin percentage) and the inventory turnover.

These factors have a different meaning for certain companies. We can compare two extreme cases, discount stores and specialized shops. Discount stores offer a narrower range of merchandise at lower prices trying to boost sales faster (higher inventory turnover). In contrast, specialized trading companies typically require more in gross profit margin to compensate for the unfavorable condition of slower sales of goods (lower inventory turnover). Specifically, specialized shops usually offer a better service and a wider choice of goods to convince consumers that the higher prices of their goods are justified.

Consumers buy goods in specialized stores and department stores or in the discount stores, depending on whether the price of the goods or the range of services, which the trading company offers to them, is more important to them. If consumers want to get a good piece of advice on which model of the required product to choose, they will be willing to pay a higher price of the goods in order to obtain a higher level of professional help. Decisions about pricing, advertising and services that the company provides to consumers, generally are considered to be marketing decisions, but it is clear that such decisions cannot be made properly without understanding and appreciation of accounting information on the interaction between the gross profit rate and turnover of inventories (Edmonds, 2000, p. 379).

For the company it is the most favorable situation when it has a high inventory turnover and when the gross profit rate is high. However, in the conditions of market competition it is normal to expect that the company is more focused on one, and less on the other of these two factors.

If managers of trading companies want to increase the return on assets, besides proper managing company's profit (gross margin), they must take into account another relevant factor usually called asset management (business resources management) of a company. Required accounting information to evaluate the quality of asset management can be found primarily in the company's balance sheet. Assets include economic resources of the company, and can be divided into fixed (long-term) and current (short-term) property. Current assets include assets that can be converted into cash over a period of one year. In the trading company, current assets include cash, accounts receivable and inventories of

goods. Accounts receivable are a form of consumer crediting and for the trading companies in the marketing sense they present an important service to consumer, aimed at encouraging sales. Merchandise inventories are the lifeblood of the trading companies. The principle benefit trading companies "offer customers is having the right merchandise inventory available at the right time and place" (Levy, 2009, p. 177).

By calculating the inventory turnover it is easy to measure success of managers in inventory management. The ratio of inventory turnover is a rough expression of inventory performance which serves to define the objectives and to measure the performance of the manager. However, the value of the inventory turnover can be significantly different depending on the type of goods and the method of calculation (cost of goods sold or revenue from the sale are placed in relation to the average value of the inventory). Average inventory turnover ratios are usually calculated by chamber of commerce or associations of entrepreneurs for certain industries.

## 2. GENERAL FEATURES AND IMPORTANCE OF THE INVENTORY TURNOVER

The speed of inventory turnover indicates the success of the companies in the use of their investments in inventories that are the primary current assets of the trading companies. It is the rate at which the trading company sells its inventories (stocks). The inventory turnover measures the speed of the inventory turnover and shows how many of the average inventory turnovers the company makes in one year, that is, how many times during the year the company is able to sell a quantity of goods corresponding to its average inventory.

Monitoring the size of the inventory turnover serves as the inventory analysis techniques and as a means to maintain optimal levels of inventories in the company. The inventory turnover can be calculated in two ways. One it is as the ratio between the cost of goods sold during the year and the average capital invested in inventories during the year (average inventory at cost)[4], while the second represents the ratio between the revenue from the sale of goods (net sales) and the average capital invested in inventories during the year (average inventory at cost), also called sales-to-stock ratio[5]. Thus, the following applies:

$$KO1 = \frac{\text{cost of goods sold}}{\text{average inventory at cost}}$$

$$KO2 = \frac{\text{net sales}}{\text{average inventory at cost}}$$

Accordingly, the required information to calculate the speed of turnover of the inventory are the cost of goods sold and the revenue from the sale of goods (from the profit and loss account), and the average inventory of the goods at cost (from the balance sheet of the company). The value of the inventory is contained in the balance sheet on a particular day (usually at the end of the fiscal year), and the average inventory should be calculated as the average of the beginning and finishing annual inventory, or even as the average of

[4] See, eg: Chasteen, 1992, pp. 286 – 287.
[5] Levy, 2009, p. 334.

monthly or daily inventories during the year for a more accurate calculation of the inventory turnover speed.

In calculating the inventory turnover ratio, it is necessary to bear in mind the following facts (Schreibfeder, 1997):

First, only the purchase value of goods sold from a warehouse of the companies is taken into account (whereas the goods that are not held in stock or direct shipment are not taken into account, since they do not take up storage space or involve equity firms).

Second, the size of cost of goods sold (COGS) in the numerator formulas contain and transfer the stored goods to other departments as well as the quantity of the goods, which is used for internal purposes, such as repairs and installation.

Third, the inventory turnover ratio based on the purchase value (which it is paid by company) or to the selling price (which company charges from buyers).

In the denominator of the formula for calculating the inventory turnover, the average value of inventories during the year is used. In determining the average value of capital invested in inventories (Schreibfeder, 1997):

1. Calculate the total value of all commodity items in inventory (quantity on hand times cost) every month, on the same day of the month. It is necessary to take into account the principle of consistency and ensure the use of the same cost basis (average cost, last cost, replacement cost, etc.), in order to calculate both the cost of goods sold and average inventory investment.
2. If inventory levels in the company fluctuate throughout the month, calculate the total inventory value on the first and fifteenth day of every month.
3. Determine the average inventory value by averaging all inventory valuations recorded during the past 12 months.

Success in inventory management is measured by the inventory turnover. Managers of the trading companies, responsible for the investment in inventories and for the success of inventory management, strive to achieve a high inventory turnover. Increasing the inventory turnover can increase sales volume (the inventory consists of newer goods that sells better and faster), improve salesperson morale (they offer constantly new goods), reduce the risk of goods obsolescence (especially fashion and perishable goods), reduce the need for lower prices and provide more resources to take advantage of new favorable opportunity for buying and profitability raising, for example, in situations where the vendors wants to get rid of large inventory offering goods at low prices (Levy, 2009, p. 336).

When managers try to speed up the inventory turnover of their companies they must take into account the impact of measures to increase the inventory turnover on gross profit. Specifically, the inventory turnover can be increased in two ways (Levy, 2009, p. 337):

First, by reducing the number of merchandise categories, the number of stock keeping units (SKU) within a category or the number of items within a stock keeping unit, which means narrowing the range that can cause a decrease in sales of goods.

Second, by means of buying merchandise more often and in smaller quantities, which reduces the average inventory without reducing the sales, but by buying smaller quantities the gross profit margin decreases (buyers cannot take advantage of quantity discounts and transportation economies of scale) while operating expenses of trading business increase (higher costs of placing orders and monitoring deliveries).

Trading companies with rich sales programs have different categories of goods with different gross profit margin. While certain types of merchandise are quickly turning (up to 12 turns a year), some types of goods are slowly turning (one or even less than one turn per

year). It is necessary to calculate the inventory turnover separately for each commodity item in every warehouse of the trading companies. This is the only correct way for the manager to identify cases in which slower turnover than the average or the normal inventory turnover is realized. It is not sufficient merely to separate slower inventory turnover, the accounting staff also needs to properly assess their value. As a general rule, inventories with a slow turnover have to be assessed at values below the actual cost (Grady, 1965, p. 242).

## 3. EMPIRICAL RESEARCH SETTINGS

The empirical research is based on a sample of 80 companies which are divided according to two criteria. The first criterion depends on the type of the merchandise range of the trading company that it sells, so we can distinguish between trading companies that sell general merchandise and specialized trading companies whose sales range is considerably narrower and focused only on a particular category of goods or services. According to this criterion 47 trading companies that sell specialized merchandise can be distinguished as well as 33 companies that sell general merchandise. The second criterion represents the size of the company. Using this criterion, the authors classified the trading companies according to the Croatian Accounting Act (Official Gazette, 109/07)[6], which distinguishes small, medium and large enterprises, depending on the parameters set on the last day of the fiscal year preceding the fiscal year for which the financial statements are prepared. Accordingly, the category of small companies consists of all the entities that meet two of the three conditions: total assets being less than HRK 32,500,000.00 with the income being less than HRK 65,000,000.00, whereas the average number of employees is less than 50. To the category of medium enterprises belong all the companies that meet two of the following three conditions: total assets is less than HRK 130,000,000.00, but it is higher than HRK 32,500,000.00; the total income is less than HRK 260,000,000.00, but it is greater than HRK 65,000,000.00, and the average number of workers is less than 250, but it is greater than 50. The category of large companies includes all the companies that exceed at least two of the three conditions listed for medium-sized businesses.

## 4. MEASUREMENT OF THE INVENTORY TURNOVER

In wholesale the inventory turnover shows the number of times the company sells its inventory balance in a given period (usually one year), while in retail it shows how many times the average inventory passes through the store during a specified period (usually one year). The trade of general consumer goods (for example, food and household items), that sells relatively fast and has shallower depth of the merchandise range (a small number of different sizes, colors, models, brands and sizes of one type of goods in stock), has high inventory turnover, in contrast to trade of goods (for example, jewelry and clothing) which has a greater depth range, relatively higher investment in inventories and slower inventory turnover.

The data from the financial statements of the trading companies in Croatia, used in this study, indicate that the average trading company that sells general merchandise had

[6] Zakon o računovodstvu, Narodne novine, 109/07.

inventory turnover (KO1) 8.79 in the year 2008, while in the year 2009 it was slightly lower and amounted to 7.69 (Table 1). However, trading companies that sell specialized goods (for example, cars) have a much lower inventory turnover (KO1). Hence, the average trading company that sells specialized merchandise had inventory turnover (KO1) 5.73 in 2008, while in 2009 it increased and amounted to 6.12 (Table 1).

Table 1: The average value of the inventory turnover (KO1 and KO2) by the type of sales range (monetary amounts in thousands)

| | Year 2008 | | | Year 2009 | | |
|---|---|---|---|---|---|---|
| | **Total of general** | **Total of specialized** | **Total all** | **Total of general** | **Total of specialized** | **Total all** |
| Number of companies | 33 | 47 | 80 | 33 | 47 | 80 |
| Value of goods sold (net sales) | 33.494.054 | 8.407.549 | 41.901.603 | 31.919.153 | 6.037.266 | 37.956.420 |
| Value of average goods sold | 1.014.971 | 178.884 | 523.770 | 967.247 | 128.452 | 474.455 |
| Cost of goods sold | 27.334.063 | 7.060.200 | 34.394.263 | 25.720.785 | 5.039.245 | 30.760.030 |
| Average cost of goods sold | 828.305 | 150.217 | 429.928 | 779.418 | 107.218 | 384.500 |
| Value of the total inventory | 3.108.500 | 1.230.794 | 4.339.294 | 3.343.553 | 822.439 | 4.165.993 |
| Value of the average inventory | 94.197 | 26.187 | 54.241 | 101.320 | 17.499 | 52.075 |
| **KO1** | **8,7933** | **5,7363** | **7,9262** | **7,6926** | **6,1272** | **7,3836** |
| **KO2** | **10,7750** | **6,8310** | **9,6563** | **9,5465** | **7,3407** | **9,1110** |

Source: authors' calculations

The calculation of the inventory turnover KO2 reaches the same conclusion as the application of the inventory turnover KO1. The trading companies with a general sales range have higher inventory turnover than the companies with a specialized sales range. In addition, in the observed period both of the inventory turnover ratios (KO1 and KO2), measured as total for all the companies, decreased their value. It is presumed that the reduction of economic activity at the macroeconomic level directly reflects on the trading companies.

In this research, trading companies were arranged by size into three groups. The two mentioned inventory turnover ratios (KO1 and KO2) were calculated for each group based on average values, with the results being presented in Table 2 and Table 3. The average large trading company in the year 2008 had an inventory turnover (KO1) 8.35, followed by the average small trading company whose ratio was 5.87. According to this scale the least successful were medium-sized trading companies with an inventory turnover KO1 reaching the value of 4.85. If we compare these three average companies using an inventory turnover ratio KO2, we will come to a changed order. According to the inventory turnover KO2, the most successful companies are the large trading companies, followed by medium-sized trading companies, and finally small trading companies.

Table 2: The average inventory turnover (KO) by the size of the trading companies for the year 2008 (monetary amounts in thousands)

| Year 2008 | Total large enterprises | Total medium-sized enterprises | Total small enterprises | Total all |
|---|---|---|---|---|
| Number of companies | 28 | 30 | 22 | 80 |
| Value of goods sold (net sales) | 38.389.631 | 2.964.444 | 547.527 | 41.901.603 |
| Value of average goods sold | 1.371.058 | 98.815 | 24.888 | 523.770 |
| Cost of goods sold | 31.608.128 | 2.268.548 | 517.587 | 34.394.263 |
| Average cost of goods sold | 1.128.862 | 75.618 | 23.527 | 429.928 |
| Value of the total inventory | 3.784.150 | 467.024 | 88.121 | 4.339.294 |
| Value of the average inventory | 135.148 | 15.567 | 4.005 | 54.241 |
| **KO 1** | **8,3528** | **4,8575** | **5,8736** | **7,9262** |
| **KO 2** | **10,1449** | **6,3475** | **6,2134** | **9,6563** |

Source: authors' calculations

In the year 2009 the inventory turnover KO1 of the average large trade company was 7.84, while a medium-sized trading company had an inventory turnover 4.05, and a small trading company had an inventory turnover 4.62 (Table 3). According to this criterion, it can be seen that the average large trading company was the most successful, followed by the average small trading company, and average medium-sized trading company. The inventory turnover KO2 provides a slightly different order. According to this ratio, the most successful company was again the average large trading company, followed by the average medium-sized company, and then the average small trading company (Table 3).

Table 3: The average inventory turnover (KO) by the size of the trading companies for the year 2009 (monetary amounts in thousands)

| Year 2009 | Total large enterprises | Total medium-sized enterprises | Total small enterprises | Total all |
|---|---|---|---|---|
| Number of companies | 28 | 30 | 22 | 80 |
| Value of goods sold (net sales) | 35.243.279 | 2.333.340 | 379.800 | 37.956.420 |
| Value of average goods sold | 1.258.689 | 77.778 | 17.264 | 474.455 |
| Cost of goods sold | 28.621.647 | 1.772.827 | 365.555 | 30.760.030 |
| Average cost of goods sold | 1.022.202 | 59.094 | 16.616 | 384.500 |
| Value of the total inventory | 3.650.079 | 436.928 | 78.985 | 4.165.993 |
| Value of the average inventory | 130.360 | 14.564 | 3.590 | 52.075 |
| **KO 1** | **7,8414** | **4,0575** | **4,6281** | **7,3836** |
| **KO 2** | **9,6555** | **5,3403** | **4,8085** | **9,1110** |

Source: authors' calculations

Analyzing the turnover of inventories (ratios KO1 and KO2) for the average trading companies of different sizes, we have come to the conclusion that the majority of small and medium-sized trading companies belongs to specialized trading companies. The inventory turnover (KO1 and KO2) in the year 2008 and 2009 has the approximately equal values of both ratios (KO1 and KO2) for specialized trading companies. The level of inventory turnover does not depend so much on the size of the trading company, as on the type of its merchandise range.

## 5. EMPIRICAL EVIDENCE FOR THE RELATIONSHIPS BETWEEN THE INVENTORY TURNOVER AND THE RETURN ON ASSETS

Trading companies that have low gross profit rates, as a rule, need to achieve high inventory turnover rates in order to operate profitably. In other words, if the company had a low gross profit margin, it required a large volume of transactions in order to achieve a sufficient total amount of profits. "Companies that sell high markup items, such as jewelry stores and art galleries, can operate successfully with much lower inventory turnover rates" (Meigs, 2001, p. 595). On the other hand, poor inventory turnover increases the risk of the lack of goods for which there is a demand from potential buyers. In this way, the risk that a trading company does not possess goods in stock that the customer is ready to buy at a certain point, increases. Therefore, the trading company is forced to urgently buy required goods from suppliers, with such orders often resulting in unnecessarily high costs (increased risk of delay of the goods ordered), which eventually reduces the profits of the trading companies.

Hence, from the previously mentioned data it is not possible to clearly indicate the relationship between the inventory turnover and profitability. To clarify the relationship between these two phenomena, an empirical study has been conducted, with the return on assets (ROA) being used as an indicator of the profitability of the trading companies. Return on assets is the ratio of profit and total assets of trading companies. The empirical study is based on two regression models:

$$\mathbf{ROA_i = \alpha + \beta(ko1_i) + \varepsilon_i}$$

where: $ROA_i$ – represents profitability of the total assets of the i-th trading company;
$\alpha$ – constant
$\beta$ – regression coefficient
$ko1_i$ – inventory turnover ratio (KO1) of the *i-th* trading company
$\varepsilon$ – residual

$$\mathbf{ROA_i = \alpha + \beta(ko2_i) + \varepsilon_i}$$

where: $ROA_i$ – represents profitability of the total assets of the i-th trading company;
$\alpha$ – constant
$\beta$ – regression coefficient
$ko2_i$ – inventory turnover ratio (KO2) of the *i-th* trading company
$\varepsilon$ – residual

The set of linear regression equations was calculated using the least squares method with the help of the econometric software package STATA. The study included 80 trading companies in Croatia and used financial and accounting data for the year 2008 and the year 2009.

Table 4 shows the results of the regression equation 3. Coefficient β is -0.197, so we have come to the conclusion that the relationship between the inventory turnover KO1 and the return on assets (ROA) is negative, that is to say that the increase in the inventory turnover tends to decrease ROA. P-value is less than 0.05, while the t-value is -2.10, which indicates the statistical significance of the results at the level of 5 percent.

Table 4: Results of regression analysis of the inventory turnover (KO1) and the return on assets (ROA)

| Source | SS | df | MS | Number of obs = | 160 |
|---|---|---|---|---|---|
| | | | | F( 1, 158) = | 4.39 |
| Model | 194.88691 | 1 | 194.88691 | Prob > F = | 0.0377 |
| Residual | 7008.11176 | 158 | 44.3551377 | R-squared = | 0.0271 |
| | | | | Adj R-squared = | 0.0209 |
| Total | 7202.99867 | 159 | 45.3018784 | Root MSE = | 6.66 |

| roa | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ko1 | -.1971291 | .0940441 | -2.10 | 0.038 | -.3828749 | -.0113834 |
| _cons | 5.090156 | .9079831 | 5.61 | 0.000 | 3.296805 | 6.883506 |

Source: authors' calculations

The results of the regression model between the inventory turnover KO2 and the return on asset (ROA), shown by equation 4, indicates a negative relationship between these two phenomena (Table 5) because the coefficient β is equal to -0.096. The regression equations are statistically significant at the 10 percent level because the p-value is equal to 0.057, while the t-value is -1.92.

Table 5: Results of regression analysis of the inventory turnover (KO2) and the return on assets (ROA)

| Source | SS | df | MS | Number of obs = | 160 |
|---|---|---|---|---|---|
| | | | | F( 1, 158) = | 3.67 |
| Model | 163.465335 | 1 | 163.465335 | Prob > F = | 0.0572 |
| Residual | 7039.53333 | 158 | 44.5540084 | R-squared = | 0.0227 |
| | | | | Adj R-squared = | 0.0165 |
| Total | 7202.99867 | 159 | 45.3018784 | Root MSE = | 6.6749 |

| roa | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| ko2 | -.0969958 | .0506388 | -1.92 | 0.057 | -.1970122 | .0030205 |
| _cons | 4.592816 | .7621184 | 6.03 | 0.000 | 3.087562 | 6.09807 |

Source: author's calculations.

Both ratios of the inventory turnover are in the negative relation to the return on assets (ROA). The negative relationship is stronger and firmer between the inventory turnover KO1 and the return on assets when compared to the relationship between the inventory

turnover KO2 and the return on assets. It is significant that both relationships are negative: no matter what method of calculation was applied, the connection remained negative. The results confirm the hypothesis that if the gross profit rate is low, a high volume of trading transactions is necessary to produce a satisfactory amount of total profits. The empirical results of this study are consistent with the research conducted by Bout et al. In their study they included 16 different industries in Belgium and found evidence of a negative relationship between the inventory turnover and the return on assets. The relationship in almost all industries is negative, and the highest value of the ratio is 0,088, while its lowest value is -0.358 (Bout, 2007, p. 9).

## 6. CONCLUSION

In the empirical research we have come to conclusion which supports the hypothesis that trading companies which sell specialized merchandise have on average smaller inventory turnover in comparison to companies that sell general merchandise. The reasons for this situation can be found in the value of individual items of merchandise. Specialized goods have mainly a higher price than general consumer goods. Thus, it is more difficult to sell them, which results in lower inventory turnover. We have noticed that trading companies that sell specialized goods belong to the category of small or medium-sized enterprises with approximately equal inventory turnover.

Required (planned) value of the inventory turnover depends on the average gross profit margin that the company seeks to achieve by selling goods. Trading companies that generate higher rate of gross profit (for example, 20 to 30 percent) seek to achieve the overall inventory turnover of 5 to 6 times a year. Companies with smaller gross margin have to strive for higher inventory turnover. Such companies cannot afford slower inventory turnover, as the companies with higher gross profit margin. The company can increase the inventory turnover when it procures smaller quantities of goods. However, in that case the company usually does not achieve adequate return on capital invested in goods, with a negative relationship between the inventory turnover and profitability being recorded, all of which was confirmed in the study.

In such cases, the company must carefully consider the effectiveness of reducing the quantities of goods that are normally purchased from suppliers. The aim is to economically dispose of limited available capital when investing in inventories. The period of tying up the capital in inventory of any goods must be limited, so in order to obtain the funds necessary for the payment of overdue accounts and for the distribution of realized profit, the company must sell all the goods purchased. Furthermore, the inventory turnover measures the speed at which inventories are moving through the warehouse of the company and measures the flow (liquidity) of a main part of its current assets. Along with other criteria, such as customer service level and the return on asset, the inventory turnover is a good barometer of the success of an enterprise.

However, managers must both carefully analyze the performance of their companies by using inventory turnover, and be careful when drawing any conclusions. The research presented in this paper provides evidence that the method of calculating inventory turnover can affect the ranking of a company's performance.

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# APPROACHES TO DISTRIBUTION CENTRE'S LOCATION PROBLEM AND ITS ROLE IN GREEN SUPPLY CHAIN MANAGEMENT

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***Abstract***

Location represents one of the five integrative areas of a supply chain management that refers to situating of facilities within a given space. Facilities of each supply chain member differ in the role one plays in supply chain and their objective function. As such, facility location problem solving accounts for different indices included into a model. Distribution centres are facilities of key importance for supply chain management. Proper location decision might add value and create value added that will significantly affect total logistics costs, service level and the whole value chain. An advanced pace in globalization, information technology development and competition results in even faster changes of consumer needs and increased demand uncertainty. This imposes even more challenge for a good location models responsive to the specific needs of the supply chain as a whole.

The aim of this paper is to provide a broad review of distribution centre location planning models from the perspective of supply chain design and to address issues these decisions have on environmental and resource utilization.

**Keywords:** location, distribution centre, location problems, models, green supply chain management

## 1. INTRODUCTION

Distribution centre (DC) can be defined as a physical facility used to complete the process of product line adjustment in the exchange channel (Bowersox et al., 1968, p.246 as cited by Hesse, 2004, p.163). Although DCs developed from warehouses their primary emphasis is placed upon product flow in contrast to storage that remains the main feature of warehouses (Bowersox et al., 1968, p. 246 as cited by Hesse, 2004, p.163). This is even more explicit in Higginson and Bookbinder (2005, p.68) when depicting DC as a type of warehouse where storage of goods is limited or non-existent. Main activities carried out in today's DCs are: Receiving; Temporary storage; Pick operations; Value added activities and production lines; Shipping; Returns processing; and data processing and office functions (Strauss-Wieder 2001, p. 10).

The problem of DC's location is a part of a more general location analysis whose origins could date back to 17$^{th}$ century (Hale & Moberg, 2003, p.22-23; ReVelle & Eiselt, 2005, p.5). Since then a vast number of scholars and pieces of literature emerged spanning over various academic disciplines and professions especially flourishing during the last five

decades (see e.g. Daskin, 2008, p.291-292; Hale & Moberg, 2003, p.23; Montreuil, 2009, p.5-2; ReVelle & Eiselt, 2005, p.1).

As a branch of operational research, location analyses refers to the modelling, formulation, and solution of a class of problems that can be described as siting facilities in some given space (ReVelle & Eiselt, 2005, p. 1). According to the same authors, location problems can be described by the following elements: (1) customers, who are presumed to be already located at points or on routes, (2) facilities that will be located, (3) a space in which customers and facilities are located, and (4) a metric that indicates distances or times between customers and facilities (ReVelle & Eiselt, 2005, p.1).

From the supply chain management (SCM) perspective, DC's location analysis is a part of a broader facility management constrained by the set of decisions that relate to the role, capacity, suppliers and markets allocated to each facility within supply chain (Hugos, 2003, p.83). Similarly, as noted by Goetschalckx, distribution system design decisions concentrate to resolve a problem on an adequate number of DCs, their location, customer and product allocation as well as their throughput and storage capacity (Goetschalckx, 2009, p.9-2). Holistic approach to DC's location analysis involves solving interrelated logistics conflicts especially those of customer service levels and costs in order to meet objectives of the value chain of suppliers and customers.

As depicted by Bowen, DCs are the nerve centers for increasingly global supply and distribution networks (Bowen, 2008, p. 379) and nodes of the network that must be laid out as best as possible to achieve its [their] mission, and similarly be located as best as possible to leverage network performance (Montreuil, 2009, p. 5-1). Network design either of supply chain either of distribution system and their optimisation deal with solving DC's location issues and need a good location models.

With the rise of consciousness on environment and on positive outcomes of the supply chain's greening - increased resource productivity, reduced waste, improved productivity and enhanced competitiveness as pointed out by Porter & Linde (Porter & Linde, 1995) - interdisciplinary research field for green supply chain management started to develop. As defined by Srivastava, green supply chain management (GSCM) represents integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to consumers as well as end-of-life management of the product after its useful life (Srivastava, 2007, p.54). Green supply chain is seen as a part of wider sustainable supply chain management. As generally defined by United Nations World Commission on Environment and Development (WCED), sustainable development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs (WCED, 1987, p.41). Accordingly, sustainable supply chain management can be defined as the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements (Seuring&Müller, 2008, p.1700). related to all this, DC's design should integrate green thinking into decision ranging from the choice of an adequate location and construction materials to layout design all aimed to resource savings and minimization of negative impacts on the environment.

The aim of the paper in the parts that follow is to provide a broad review of DC location planning models and to address issues these decisions have on environmental and resource utilization.

## 2. DC'S LOCATION MODELS

Within wider context of supply chain management, facility location decisions, including those of DCs, should be aligned with industry company works in, type of products, as well as overall company's and supply chain's strategy. As pointed out by Bowen, the locational proclivities of warehousing establishments [as well as of DCs] reflect broader tendencies in supply chain management (SCM) (Bowen, 2008, p.379-380). In other words, there is no „one fits all solution".

The locational goal of most DCs is to select a site that offers the lowest possible transportation costs with the easiest access to the greatest number of customers. The locational process typically used in the selection of an appropriate site takes into consideration the products for which a distribution facility is desired; the market area or areas that are to be served and the degree of market penetration necessary. Just-in-time has increased significantly the importance of being within a day's travel time (500 mile maximum) of supplier and customers (Empire State Development, 2008, p.6). The most important general factors that will mainly prevail in DC site-selection decision can be found in e.g. Dixon 1999; Empire State Development, 2008, p.6.

Due to interdisciplinary nature of location research as well as many stakeholders involved into supply chain design, highly complex and data-intensive engineering design efforts are needed (see e.g. Goetschalckx, 2009, 9-1).

Since facility location problems have proven to be a fertile ground for operations researchers (Daskin, 2008, p.283), they left significant legacy, especially of algorithms, to logisticians and SCM researchers used for solving DC's location as well.

### 2.1. Classification of models

There are many criteria that can be used for classification of facility problems, models and their extensions. Due to space restriction of the paper, only very broad classification of models by topography or basic space in which the problem is embedded is given herein. There is vast literature dealing with specifics and in detail of many location problems.

#### *2.1.1 Planar models*

The model presumes demands and infinite set of facility's candidate locations to accommodate them that may occur anywhere on a plane while distance metrics employed between $(x_i, y_i)$ and $(x_j, y_j)$ is a norm either the Manhattan or right-angle distance, the Euclidean or straight-line distance, the $l_{pi}$ - distance metric as a generalization of Euclidean distance or other (Drezner, & Hamacher, 2004, p 15; Klose & Drexl, 2005, p. 6).

The objective of the model is to determine the location of a single facility (represented by coordinates X, Y in a plane) such that the sum of weighted Euclidean distances to demand points *i* (represented by coordinates $x_i, y_i$) is minimized (Daskin, 2008, p. 284).

These models can be solved by nonlinear programming. Although they are insufficient for solving real-world problems, they contribute as an approximation of network model solution.

Many real-life problems are discrete or network location problems as the one of DC's location.

*2.1.2. Discrete models*

Discrete location models assume finite set of available candidate sites for facility establishment and arbitrary distance between nodes, derived from planar or network distances. These models are generally more difficult to solve as modelled as mixed integer programmes. A model can comprise many real-world assumptions that cannot be included into other models. A solution technique is exact (optimal) or heuristic (approximately optimal). Many of these models are NP-hard.

Discrete models can be divided into three broad areas that include - covering-based models that determine the critical coverage distance or time for serving demand in order to be counted as "covered" or "served adequately"; median-based models that minimize the demand weighted average distance between a demand node and the facility to which it is assigned and the models that can not be classified into any of the previous two (Daskin, 2008, p.285).

*2.1.3. Network models*

Network location models assume network space composed of nodes and links. Nodes are points of the network where demands occur while links are where travel between demand sites and facilities occur. New facilities can be sited anywhere on the network (absolute centres) while the distance between two points is computed as the shortest distance on the network. The objective of the problem is to determine the location of *p* facilities on network such that the demand-weighted total distance between the facilities and the nodes is minimized. Therefore, the demand is assigned to the closest facility. This class of problem is termed as *p*-median problem on the network for which exists at least one optimal solution that has all *p* facilities located solely at the nodes of the network – node centers (ReVelle & Eiselt, 2005, p.7-9).

For the formulation of the problem (see e.g. Daskin, 2008, p. 287; Marianov & Serra, 2009, p.4; ReVelle & Eiselt, 2005, p.7).

Logistics engineering benefits from these problems and algorithms set. As stated by Goetschlackx the objective of the distribution system design is to minimize the time-discounted total system cost over the planning horizon subject to service-level requirements. The total system cost includes facility costs, inventory costs, and transportation costs. The facility costs include labor, facility leasing or ownership, material handling and storage equipment, and taxes (Goetschalckx, 2009, 9-2).

In that order the following models for distribution system design can be distinguished (Goetschlackx, 2009, 9-9 – 9-15).

**2.2. K-Median Model**

This model solves the problem of number and location of DCs and the customer allocations with objective of minimizing the total system cost. It assumes establishment of DCs anywhere over distribution area as it is wholly covered by the set of customers (planar problem). Model assumes binary variable status of DC, no capacity restrictions to DCs and no upper bound for customer allocation. The problem can be formulated as in (Goetschlackx, 2009, 9-9).

The problem can be solved with a mixed-integer programming solver. The advantages of the model are its practical usage for realistic problems solving, control delivery to

designer of the system over upper bound of DCs to be established and assignment costs. The main disadvantages of the model are a single time period usage and an exclusion of site-related costs.

### 2.3. Location-allocation models

This model delivers solution to location and customer allocation problem considering transportation costs only. Beside DCs and customers, it considers sourcing facilities (plants) and flows between them, as well. Unlike the previous, this model allows uncovered design area and capacitated DCs. Location allocation model is conducted by two sub - algorithm /phases. The first, allocation phase, starts with predefined DCs locations for which network flow algorithm calculates the transportation distances *d* and allocate customers within the available DCs capacity. The second, location phase, determines the new locations for DCs by computing the minimum sum of the weighted distances for each flow between each plant and DC. The problem can be formulated as in (Goetschlackx, 2009, 9-12).

While the network flow formulation can be solved by a linear programming solver, the solution of the location phase is iterative and represents an approximation of the DC location dependable on the DCs initial phase configuration.

The advantages of the model are inclusion of capacity variables and establishment of DCs even in those areas not covered by customers. Moreover, it locates DCs within design area without considering its feasibility within the area (e.g. due to natural or artificial obstacles of terrain) turning this to its disadvantage. Besides this, it gives an approximate solution to DCs siting and suffers from the same deficiencies as K-median problem.

### 2.4. Warehouse Location problem

This model sets DCs within a finite set of candidate locations (discrete model; a site-selection model) for which site- dependent costs are also known and can be included into the model. It assumes no capacity restrictions. Decision on location of DCs represents a trade-off between fixed and variable transportation costs. The problem can be formulated as in (Goetschlackx, 2009, 9-12).

The model can be reformulated to include site-dependent costs or to evaluate savings of the opening of new DC (Goetschlackx, 2009, 9-12).

### 2.5. Geoffrion and Graves Distribution System Design Model

This model includes constraints on capacity and single-sourcing. It is formulated as (Goetschlackx, 2009, 9-14):

$$Min \quad \sum_{ijkp} c_{ijkp} x_{ijkp} + \sum_{j} \left( f_j z_j + h_j \sum_{kp} dem_{kp} y_{jk} \right) \qquad (1)$$

$$s.t. \quad \sum_{jk} x_{ijkp} \leq cap_{ip} \qquad \forall ip \qquad (2)$$

$$\sum_{i} x_{ijkp} = dem_{kp} y_{jk} \qquad \forall jkp \qquad (3)$$

$$\sum_{j} y_{jk} = 1 \quad \forall k \tag{4}$$

$$TL_j z_j \leq \sum_{pk} dem_{kp} \; y_{jk} \leq TU_j z_j \quad \forall j \tag{5}$$

$$x_{ijkp} \geq 0 \;,\; y_{jk} \in \{0,1\},\; z_j \in \{0,1\} \tag{6}$$

where:

| | |
|---|---|
| $c_{ijkp}$ | Unit transportation cost of servicing customer *k* from supplier *i* through depot *j* for product *p*. |
| $f_j$ | Fixed cost for establishing a DC at candidate location *j*. |
| $h_j$ | Unit handling cost for DC at candidate location *j*. |
| $cap_{ip}$ | Supply availability (capacity) of product *p* at supplier *i*. |
| $dem_{kp}$ | Demand for product *p* by customer *k*. |
| $TL_j, TU_j$ | Lower and upper bounds on the flow throughput of DC at candidate location *j*. |
| $z_j$ | Status variable for DC at candidate location *j*, equal to 1 if it is established, zero otherwise. |
| $y_{jk}$ | Assignment variable of customer *k* to DC at candidate location *j*, equal to 1 if the customer is single –sourced from center, zero otherwise. |
| $x_{ijkp}$ | Amount of flow shipped by supplier *i* through DC *j* to customer *k* of product *p*. |

Constraint (1) minimizes the sum of the transportation cost, fixed facility costs, and DCs handling costs.

Constraint (2) ensures sufficient product availability at the suppliers.

Constraint (3) ensures that the customer demand is met for each product and ensures conservation of flow for each product at the DCs.

Constraint (4) forces every customer to be assigned to a DC.

Constraint (5) ensures that the flow through the DCs does not exceed the throughput capacity and that, if a DC is established, it handles a minimum amount of flow.

This problem formulation is solved by Bender's decomposition and can be used for many real-world situations. Although advances in computer processors and commercial software do not impose use of Benders decomposition, it is still necessary in cases of largest problems or uncertainty (for details see e.g. Goetschlackx, 2009, 9-15).

Besides mentioned, there are many other models that do not include real-world assumptions and the limitation. In spite of that they can be used as a simple and good starting point for determining candidate location for DC's siting. These include *locational cost-profit-volume analysis* that indicates the best one among many candidate locations by analysing total cost, total profit and break-even output level, *the transportation model*, *factor rating* or *center-of-gravity method* (Stevenson, 2009, p.385-388; Swink et al, 2011, p.329).

## 3. CONCLUSION

A broad review of distribution centre planning models from the perspective of supply chain design has been presented in this paper. Various approaches to distribution centre's location have been provided as well. Due to long tradition and interdisciplinary nature of the location research many location models, their variations and extensions have been developed so far and incorporated into a huge location research area. As simplifications of reality, models presented herein represent very broad basics used to solve a wide spectrum of real-world problems that are not restricted only to geographically siting of distribution centres.

Due to strategic importance of location decisions and many stakeholders included and affected by them, location research continues to be a very vivid study area dealing with research topics and models as new issues emerge. Environmental issues, as land resources use and green transportation, are some of them.

Modern distribution systems and supply chain design require adequately located facilities that will minimize costs of opening and operating them as well as costs of outbound and inbound transportation costs while maintaining the service level demanded by customers. Since many of the current supply chain management practices have been questioned from the perspective of green and sustainable, especially in relation to land use and transportation, new solutions have already been designed and implemented, at least by the most successful actors. Support of information technology in this field is inevitable. All this transform a location deciding to a business process that enables sustainable or at least green differentiation, competitiveness and overall prosperity.

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# CHOICE OF LOCATION FOR RETAIL BUSINESSES

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***Abstract***

Location selection is one of the key success factors of retail businesses. Location determines the number of contacts with customers, business volume and total income of retail business. To prove the hypothesis of location as the decisive factor in retail businesses, the following paper apllied scientific analysis and synthesis methods, mathematical methods and methods of interviewing. The obtained findings are based on the analysis of supermarkets locations in towns Gospić and Požega. The purpose of analysis of these practical examples is to examine to what extent retail businesses use location as a means of competitive advantage, while the method of interviewing is an attempt to answer the question of importance of location for customers when deciding on the place of purchase.

**Keywords:** retail organizations, location, competitive advantage

## 1. INTRODUCTION

Location of retail network is the basis of the overall operating system of retail businesses. A good location can compensate for management deficiencies, but even the best management cannot compensate for the shortcomings of selected venues. The subject of importance for this paper is the microlocation of retail network, and the microlocation of leading supermarket chains in the cities of Gospić and Požega. Microlocation is a fixed spot in a rural or urban environment, in a particualar area within a city or settlement (Karić,

2005, p. 17). Aim of this study is to investigate whether and to what extent supermarkets in smaller cities, such as Gospić and Požega, use location as competitive weapon, that is if supermarkets in these cities decide to pursue the policy of tracking customers or the policy of attracting them (Lovreta et al, 1991, p. 200) in choice of location. Following the policy of attracting, retail chains tend to locate in close proximity to each other (to follow the competition), and constantly expand the market area as to increase the number of potential and actual customers. The policy of tracking is applied when retail chains decide to locate themselves as close as possible to potential customers, which usually means high cost investment, since they are either located in the city or its immediate vicinity. To prove the hypothesis of location as the decisive factor in retail businesses, and to ensure the applicability of the obtained knowledge, field research was conducted as well. Field research consisted of interviewing customers in the cities of Gospić (N=50) and Požega (N=41). The primary data was collected using self-administered questionnaire. A total of 91 valid questionnaires were collected. Data were collected by interviewing customers in front of supermarkets. The descriptive statistics analysis was performed to analyze data.

## 2. RESEARCH PROBLEM AND THEORETICAL BACKGROUND

One of the most important strategic decisions made by retail organizations is where to locate their operations. Because location is such a significant cost driver, the consulting McKinsey belives „location ultimately has the power to make (or break) a company's business strategy“ (Bartness,1994, p. 32). Once management is committed to a specific location, many costs are firmly in place and difficult to reduce.

The location decision ofthen depends on the type of business. For retail and professional service organizations, the strategy focuses on maximizing revenue. Table 1 provides a summary of location strategies for retail organization.

Table 1 Location strategies of Service/Retail/Professional organization

| |
|---|
| ***REVENUE FOCUS*** |
| ***Volume/revenue*** |
| Drawing area; purchasing power |
| Competition; advertising/pricing |
| ***Physical quality*** |
| Parking/access; security/lighting; appearance/image |
| ***Cost determinants*** |
| Rent |
| Management caliber |
| Operations policies (hours, wage rates) |
| ***TECHNIQUES*** |
| Regression models to determine importance of various factors |
| Factor-rating method |
| Traffic counts |
| Demographic analysis of drawing area |
| Purchasing power analysis of area |

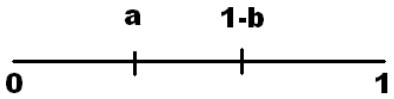
| |
|---|
| Center-of-gravity method |
| Geographic information systems |
| ***ASSUMPTIONS*** |
| Location is a major determinant of revenue |
| High customer-contact issues are critical |
| Costs are relatively constant for a given area; therefore, the revenue function is critical |

Source: (Heizer & Render, 2004, p. 312)

When retail organizations make decisions about location of its facilities they must consider competitors' strategy, size, etc. A fundamental decision retail organization make is whether to locate their facilities close to competitors or far from them. How the retail organizations compete and whether external factors force them to locate close to each other influence this decision.

Hotteling was one of the first to introduce the principle of spatial competition by investigating how sellers would choose locations along linear market (cf. figure 1).

Figure 1. Two firms Locating on a Line




If total demand is 1, firm 1 locates at point a, and firm 2 locates at point 1-b, the demand of the two firms $d_1$ and $d_2$, is given by following (Chopra & Meindl, 2001, p. 310):

$$d_1 = \frac{1-b+a}{2} \text{ and } d_2 = \frac{1+b-a}{2} \quad (1)$$

Clearly, both firms maximize their market share if they move closer to each other and locate at a=b=1/2.

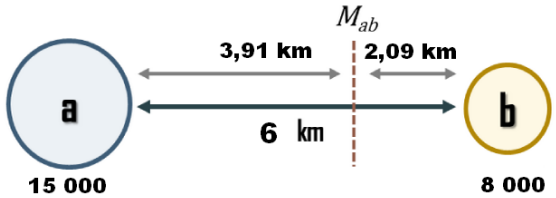
According to Hotelling's Law, there is an „undue tendency for competitors to imitate each other in quality of goods, in location, and in other essential ways" (Hotelling, 1929, p. 41). Hotelling's law explains why retailers and restaurants so often locate near one-another. The classic example is ice-cream vendors locating near one another on a beach. He used a simple model in which consumers are evenly dispersed along a line and buy from the nearest firm. The total price to the customer is thus the market price plus the transport cost (times or mony spent to go to the market). The two firms (A and B) choose to locate at the mid-point of the line. A firm that unilaterally moves away from the mid-point loses market share and profit.

In theory and practice of determining a market area of retail organization we have to mention two more laws: Reilly's law and Huff's law (Rodrigue, 2006, p. 98). The task of Reilly's law of retail gravitation (1931) is to find a point of indifference between two locations, so the market area of each can be determined. This point is asumed to be a function of the distance between two locations diveded by their respective size (population).

$$Mab = \frac{Dab}{1+\sqrt{\frac{Pb}{Pa}}} \quad (2)$$

One location can thus be more attractive than another. For instance, on figure 2 two locations in the town are 6 km apart.

Figure 2. Reilly's law



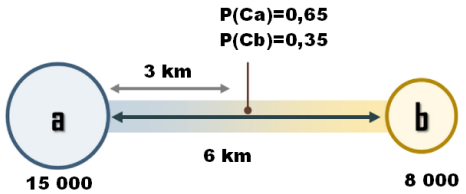

According to the Hotelling principle, the point on indifference should be halfway between (3 km). However, since loaciton A (15 000) has a larger part of town population than location B (8 000), it is assumed that it will draw more customers. Under suhch circumstances, the point of indifference is 3,91 km away from location A (cf. figure 2).

Huff's retail model (1963) assumes that customers have a choice to patronize a location in view of other alternatives and thus a market area is expressed as probabilities. The poinf of indifference becomes the point of equal probability that a customer will patronize one location or another.

$$P(Ca) = \frac{\frac{Pb}{Da}}{\sum_{a}^{n} \frac{Pa}{Dab}} \quad (3)$$

On figure 3, a customer has a greater chance (0,65) to patronize location A at the midpoint than to patronize location B (0,35).

Figure 3. Huff's law




As you can see the Huff's retail model leaves room for the customer choice. We can conclude that market, market, market is a more-appropriate concept for the future as retailers alike ask not "Is this a good location," but rather "Is this the best location in the market, given the competition?"

## 3. RESEARCH RESULTS AND DISCUSSION

There are six currently operating supermarkets in the town of Požega (28 209 inhabitants in the town and its surroundings). These are Getro, Kaufland, Konzum, KTC (Križevci Shopping Centre), Lidl and Plodine (cf. Map 1).

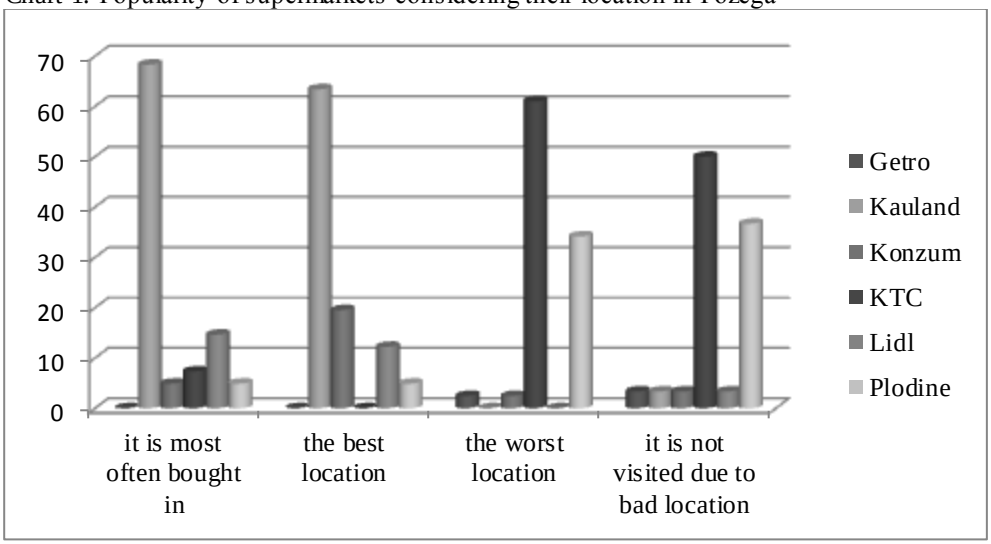
Map 1. Supermarket locations in the town of Požega


Source: Authors prepared

The specified stores belong to the same category, are of almost the same range, of similar size, all of them have a parking lot and adequate access from the main road. In addition to these, there are many more smaller stores and shops in town, including drugstores, perfumeries and specialized stores. All of them have customers, but the assumption is that if purchases are made at certain intervals, they are made in supermarkets.

In Požega, 41 customers participated in the survey. 85,37% were car owners. 78,05% participants find the location important, while 21,95% do not think of location when deciding on their place of purchase. Main results are presented graphically in Chart 1.

Chart 1. Popularity of supermarkets considering their location in Požega




Source: authors' research

According to our research, the most popular supermarket in Požega is Kaufland, where 68,29% of participants make their purchases. It is followed by Lidl with 14,63%, KTC with 7,32%, and finally Konzum and Plodine with only 4,88% of customers. The main reason for choosing any of the former supermarkets is location with 46,34%, followed by price 39,02% and additional contents (hair salons, pizza restaurants, perfumeries and boutiques) with 7,32%. 63,41% of participants think that Kaufland has the best location, followed by Konzum with 19,51%, Lidl with 12,2% and Plodine with 4,88%. Participants explained their choice of Kaufland's location was the result of easy access from the main road via roundabout, proximity to the town centre, the possibility of coming by foot, proximity to the bus and the train station, and the large parking area.

According to our research, supermarkets in Požega with the worst location are KTC with 60,98% and Plodine with 34,15%. Explanations for chosing KTC as the worst include great distance from the town centre, location on secondary road, no possibility to arrive by public transport, nor the possibility of coming by foot because of distance from the town, and thus being suitable only for residents in the immediate proximity of the supermarket. Consumers who choose KTC, come specifically because of prices. The location of Plodine was the topic of many discussions in Požega since the opening. Like KTC, Plodine is far away from the town centre, but there is also the problem of poor transport regulations.

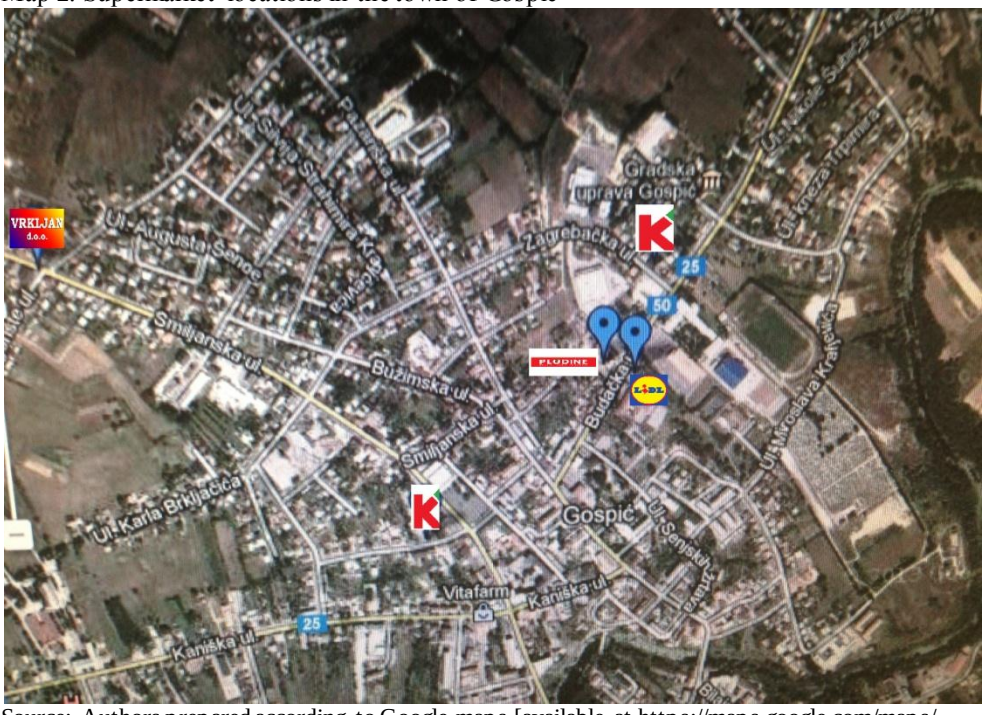
The presented results evidently indicate that location of supermarkets in Požega represents a significant competitive advantage. This is also confirmed by 73,17% of participants claiming the main reason of avoiding a supermarket is down to location. Of these, as many as 50% said the supermarket they avoid is KTC, because it is never along the way, there is no additional content and the distance from the town is too great. Fewer participants (36,67%) said the same for Plodine, adding the already mentioned poor transport regulations.

It might be stated that most of the supermarkets in Požega were pursuing the independent policy of attracting customers in their choice of location, while Kaufland put

greater emphasis on the tracking strategy. Therefore, it is not surprising that the majority of participants chose Kaufland's location as the best in Požega. This could be confirmed by participants' relatively good evaluation of Konzum and Lidl, located near Kaufland, apparently in attempt to mutually expand the market area.

In the town of Gospić (12 792 inhabitants by the year 2010), there were six supermarkets as well. Following the arrival of other supermarkets in town, Billa was forced to close their 760 $m^2$ supermarket in 2005 due to poor business performance. Currently, there are five operating supermarkets in Gospić. These are Plodine (Budačka Street), Lidl (Budačka Street), Konzum Maxi (Zagreb Street), Konzum (S. Radić Square) and Vrkljan (Smiljanska Street) (cf map 2).

Map 2. Supermarket locations in the town of Gospić



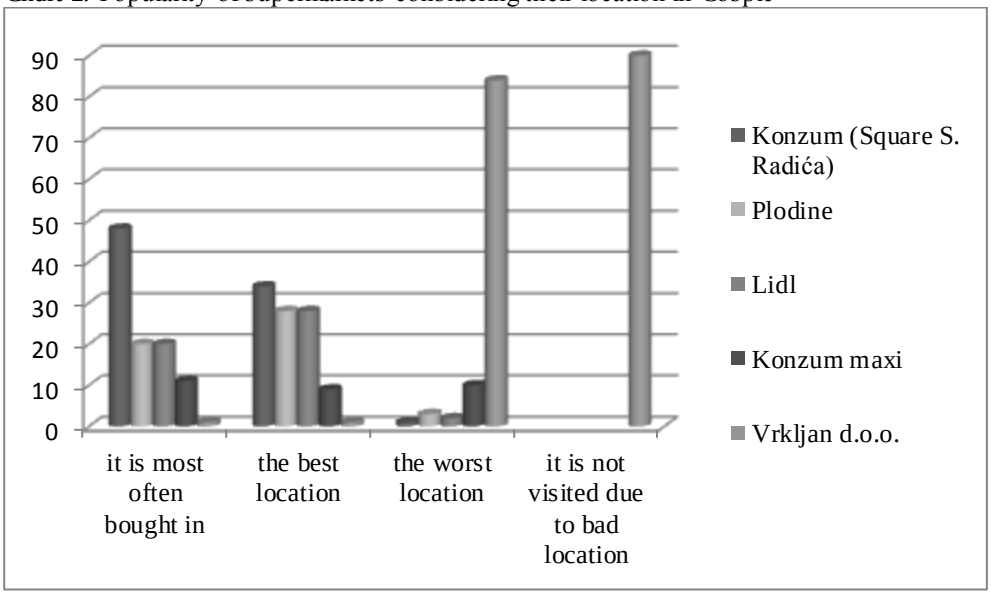

Source: Authors prepared according to Google maps [available at https://maps.google.com/maps/, access 15.08.2013.]

In Gospić, there were 50 participants of our survey. 85,55% of them were car owners. Importance of location was confirmed by 89,05%, while the other 10,95% put no emphasis on location. The main results are shown by Chart 2.

According to our survey, the most popular supermarket in Gospić is Konzum (S. Radić Sq.) with 48% participants shopping there. It is followed by Plodine with 20%, Lidl with 20%, Konzum Maxi with 11% and Vrkljan with only 1%. Main reason for choosing these supermarkets is price with 65,53%, while location is the most important for 34,47% of participants. The best located is Konzum with 34% (S. Radić Sq.), followed by Lidl and Plodine with equal 28%, Konzum Maxi with 9% and Vrkljan with 1%. Interesting to notice, the identical percentage of participants have chosen Lidl and Plodine (located across from

each other). This location is easily accessed from the main road, the town centre is nearby, customers often shop in both supermarkets at the same time, it is close to workplace and has a large parking area.

Chart 2. Popularity of supermarkets considering their location in Gospić




Source: authors' research

According to our survey, Vrkljan has the worst location in Gospić with 84%, Konzum Maxi with 10%, Plodine with 3%, Lidl with 2% and Konzum (S. Radić Square) with 1%. Given explanation of bad location is great distance from the town centre, so the supermarket is almost inaccessible by foot and thus only suitable for residents in the immediate vicinity.

These results apparently show the importance of location as a significant competitive advantage in Gospić. The significance of location is confirmed by 90,98% of participants who claim the main reason of avoiding a supermarket is location. Supermarkets in Gospić have mainly decided on the policy of attracting (Lidl, Plodine, Konzum) and the policy of tracking (Konzum). Most supermarkets are easily accessible. Our research shows that in order to increase competitiveness Lidl focused on microlocation and pricing strategy, while Plodine is the most comfortable shopping place.

## 4. CONCLUSION

Many of the issues with choice of location for retail businesses can be pinned down by profit maximization rule, where revenues of a retail store depend on intensity of competition in its vicinity. For purposes of this paper, the above-mentioned supermarkets are of approximately the same size, so their revenues could be regarded as inversely proportional to distance from the customers. Results of this study support the above claim and confirm the importance of location; as demonstrated, location is the competitive

weapon of supermarkets in smaller towns such as Požega and Gospić. Importance of location was stated by 83,5% of participants (N=91). In both towns, the least visited supermarkets were those adversely situated, while the most popular were those with best perceived locations. Location analysis of supermarkets in Gospić and Požega confirmed that retail chains use location as a competitive weapon, but they are also trying to locate in close proximity. This is especially true for supermarkets in Gospić, less so in Požega. Using location as a competitive weapon is far greater in Požega. The reason for this may be found in size of both towns – since Gospić is smaller, chances to succeed may be increased by pursuing the policy of tracking. Location decisions of Kaufland in Požega and Konzum in Gospić were probably made in line with the policy of tracking customers, though it should be noted that choice of Stjepan Radić Square for Konzum is also due to the proximity of then still operating Billa.

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# III. LOGISTICS CASE STUDIES

# EVALUATING LOGISTICAL CHAIN IN SLOVENIAN COMPANIES

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***Abstract***

The current market situation, followed by fast growing globalization's effects has been constantly searching for new approaches in modeling and managing transport-logistics chains. These are approaches where all determinants for efficient and effective management of ever complex supply chains have been properly set and exploited.

This paper focuses on logistics performance of industrial firms in the Slovenian market. Our research explored the current attitudes of managers in the logistic industry. Specifically, we examined their perception of different characteristics of a logistics provider and their evaluation in the process of outsourcing. There are few logistics functions that have been outsourced. Outsourcing is a dynamic process that should evolve with changes in the company's business needs, internal capabilities, and competitive environment.

The authors will intend to answer the following question in the research: Which indicators do customers use to evaluate their suppliers? It would be expected that in purchase decision processes, customers give strong consideration to the resources and the competence of the supplier as criteria to provide higher quality and more reliable and efficient transportation of goods. Therefore, the service provider must ensure complete execution of all logistics and related activities.

**Keywords:** logistical services, outsourcing, logistical provider, logistics

## 1. INTRODUCTION

Operating conditions in logistic industry with the accession to European Union change considerably. Slovenia has already joined to European Union, but also other transition countries in the Former Yugoslavian countries will face the time of accession to the European common market. Therefore, for companies operating in those markets primary goal is to extensively prepare for the new business environment.

Competition among logistical companies is increasing because of these changing market conditions in the Former Yugoslavian countries. Slovenian logistical companies are adapting to new common European market. They are reacting to strong competition in logistics industry by becoming more involved in the supplier selection process, by outsourcing logistical services and by becoming more critical, detailed, and comparative in their supplier evaluation. Logistics companies in Former Yugoslavian countries are adapting to development guidelines at various levels. Like Mentzer, Myers, Cheung (2004)

argued logistics offerings are subject to differences across countries. Logistics service expectations differ across national and cultural boundaries, enhanced personal interaction frequently occurs in service settings, and service use patterns frequently differ across countries as well as more traditional influences such as timeliness and responsiveness.

## 2. LITERATURE REVIEW

The basic concept of outsourcing is unambiguous: It involves choosing a third party or outside vendor to perform a function or tasks supporting that function in order to incur business benefits. The outsourcing arrangements can be grouped into four categories: out-tasking; co-managed services, managed services and full outsourcing, also known as business process outsourcing (Sanders, Locke, 2005).

As recently as a decade ago, 3PL was an emerging industry in many parts of the world. However, the rate at which use of these services grew, the rate of growth across functions and the reasons for this growth differed in different parts of the world. In Europe, firms tend to use 3PL both for international transport and for the distribution of products in foreign markets (Carballosa, and Tarre´s, 2011; Manuj, and Sahin, 2011). Nearly two-thirds of the European distribution centres used by American, Japanese, Korean and Taiwanese manufacturers are managed by 3PL providers (Mckinnon, 1999). 3PLs helped firms deal with multinational transportation requirements and inconsistencies (Wieland and Wallenburg, 2012).

Mentzer, Myers and Cheung (2004, 15) found out that logistics services have become a significant source of competitive differentiation between firms. »Diverse regulations across borders, longer lead times, and increased transportation costs all add to the difficulty of managing logistics services internationally. As a service offering, logistics is often characterized by intensive customer contact, extensive customization requirements, and a reliance on extrinsic cues for service performance. Because of these qualities, logistics services are also subject to cultural influences that exist in cross-border trade«. In the case Balkans countries exists several differences (religious and cultural issues, trade regulations, shipping distances, and cross-currency issues etc.) between them and as a result we found different research results. And as further Mentzer, Myers and Cheung (2004, 15) suggested that identifying specific customer segments, some which may transcend national borders, logistics managers can benefit from reduced costs, enhanced revenue, and the ability to differentiate their offering from the highly competitive marketplace.

The buying behavior literature suggests that the importance of particular purchase makes a difference in terms of the buying process. A purchase can be important for the firm for several reasons. Purchased service attributes can be differentiate based on whether they are standard or nonstandard, simple or complex and have a standard or a novel application. Purchases involving large expenditures, difficult to obtain items, or irreplaceable supplies are very important or "strategic" buys (Maltz and Ellram, 2000). We are agree that purchasing industrial services, like logistical services, is a time-consuming, complex, and expensive activity.

Which indicators customers use to evaluate their suppliers? We would expect that in their purchase decision processes, customers would give strong consideration to the resources and the competence of the supplier as the means necessary to provide higher quality, more reliable and more efficient transport of goods; therefore, the service provider must ensure a complete execution of all logistics and related activities. Vaidyanathan

(2005, 93) argued that logistics managers consider information technology, quality, cost, services, performance and intangibles as important factors in selecting logistics providers.

One of the major challenges of services marketers is the assessment of the quality of service offerings. Because of the general nature of services (i.e. intangibility, inseparability, heterogeneity, and perishability), service quality is usually difficult for customers to evaluate (Palmer and O'Neill, 2003).

As Svensson (2002, 426) said »altogether, marketing activities and logistics activities may be seen as a chain of interdependent activities that complement each other in order to facilitate the exchange.«

## 3. EMPIRICAL FINDINGS

### 3.1. Company profile

The main research instrument for empirical investigation, e.g. a questionnaire, was developed on the derived theoretical basis. The covering letters with questionnaires were mailed to the corporate directors of 150 the biggest Slovenian enterprises. We choose the strata based on the annual net profit. During the four-week period following the mailing, a total of 37 responses were received and that gave the response rate of 24,7%. The results present in this paper are related to the sample of 37 respondents.

The relevant data of the companies were provided mainly by members of the managing boards (70,3% of cases). Other respondents appeared in not more than three companies.

Table 1: Position of respondents in the companies

| Position in the company | Frequency | Percent (%) |
|---|---|---|
| Members of the managing board | 26 | 70,3 |
| Head executive | 4 | 10,8 |
| Counselling specialist | 2 | 5,4 |
| Business consultant | 2 | 5,4 |
| Other | 3 | 8,1 |
| Total | 37 | 100,0 |

The companies included in the sample are distributed according to industries (see Table 2).

Table 2: Distribution of the companies in the sample according to industries

| Industry | Frequency | Percent (%) |
|---|---|---|
| Production of industrial products | 11 | 29,7 |
| Trade | 9 | 24,3 |
| Production of consumer products | 6 | 16,2 |
| Business services | 6 | 16,2 |
| Services for final consumer | 5 | 13,5 |
| Total | 37 | 100,0 |

### 3.2 Market characteristics and business strategies of entrance on foreign markets

Then respondents in the surveyed companies were asked about their largest sales geographic region. The respondents had the possibility to choose among different answers. The results show that the largest respondent sales market is Slovenia, followed by markets of former Yugoslavian countries. The next large sales market is the market of EU countries, followed by the market of East Europe.

Table 3: Respondents largest sales geographic region

| Geographic region | Frequency | (%) |
|---|---|---|
| Slovenia | 36 | 97,3 |
| Former Yugoslavian countries | 27 | 73,0 |
| EU | 25 | 67,6 |
| East Europe | 25 | 67,6 |
| CEFTA | 22 | 59,5 |
| USA | 12 | 32,4 |
| Pacific - Asia | 10 | 27,0 |
| Australia and New Zeeland | 9 | 24,3 |
| Japan | 8 | 21,6 |
| Africa | 8 | 21,6 |
| Latin and Middle America | 6 | 16,2 |

The presented research findings in the continuation relate to the above-stated sample of companies.

One of the main issues of research was to explore the business strategy of entry in the new market in the sample of Slovenian companies. With the growth of international trade, an increasingly diverse array of products of different national origins is now available in many countries throughout the world. This has resulted in greater interest in examining the primarily business strategy of entry in the foreign markets. The respondents had the possibility to choose among different answers. The data analysis shows that the most often planned business strategy in the sample of Slovenian companies were the strategy of market development (76,3%) and the strategy of new product development (73,7%). Opening the own company's subsidiary in the foreign market (50,0%) was the next most often used business strategy, following by outsourcing (42,1%), the strategic alliances with other companies appeared in 39,5 percent of cases while alliances with companies of raw materials appeared in 31,6 percent of respondents. The less often used business strategy for the entry in the foreign market was by respondents the licence agreement (13,2%).

Table 4: Business strategies used for entry in the foreign markets

| Business strategy | Frequency | Percent (%) |
|---|---|---|
| Market development | 29 | 76,3 |
| Product/service development | 28 | 73,7 |
| Opening of company's own subsidiary in the foreign market | 19 | 50,0 |
| Outsourcing | 16 | 42,1 |
| The entrance on foreign market with alliances | 15 | 39,5 |
| The strategy of alliances with companies of raw materials | 12 | 31,6 |
| Licence agreement | 5 | 13,2 |

### 3.3 The overview of logistics in Slovenian companies

In our research we were interesting if Slovenian companies are planning, executing and control the whole logistical chain. The 78,4 percent of respondents answer in the affirmative, while the remaining 21,6 percent of respondent answer in the negative. Results show that respondents are aware of managing the entire logistical function.

Table 5: The indicators to evaluate logistics suppliers

| The indicators to evaluate logistics suppliers | Frequency | Percent (%) |
|---|---|---|
| Competitive price and payments conditions | 26 | 68,4% |
| Adequate quality of logistical services | 23 | 60,5% |
| On-time delivery | 21 | 55,3% |
| Reliability of offered logistical services | 17 | 44,7% |
| Technical equipment and ability to manage the entire logistical function | 12 | 31,6% |
| The full service of logistics and connected services | 10 | 26,3% |
| The speed of delivery | 7 | 18,4% |
| The size of logistics provider | 1 | 2,6% |

One of the objectives of the paper was to explore which indicators customers use to evaluate their suppliers. Respondents had the possibility to choose among different answers. Results show (see Table 5) that the competitive prices and payments conditions were by respondents the important factors in selecting logistics providers (68,4%). The research suggests that respondents are given more importance to following factors in choosing logistics provider: adequate quality of logistical services (60,5%), on-time delivery (55,3%) and reliability of logistical services offered (44,7%). Managers also consider technical equipment and ability to manage the entire logistical function, the full service of logistics and connected service and the speed of delivery as important factors in selecting logistics providers. From results, it appears that firm characteristics (such as the size of logistics provider) influence the choice of logistics providers.

Purchasing industrial products and services is a time-consuming, complex, and expensive activity. To properly understand organizational buying we must be knowledgeable about the business buying centre concept. One way to view a buying centre

is to categorize members which decide of purchases. It is useful to consider the various people within an organization who might be called upon to contribute to a purchasing decision. One individual or a group of individuals may perform different roles; he can act as initiator, gatekeeper, influencer, decider, user or buyer (Mahin 1991).

The results show that the purchase department is usually taking the buying decision (55,3%), followed by the logistics department (47,4%) and sales department or marketing department (36,8%). Directors are also taking buying decisions (28,9%). Respondents had the possibility to choose among different answers.

Table 6: Department taking a buying decision

| **Department** | **Frequency** | **(%)** |
|---|---|---|
| Purchase department | 21 | 55,3% |
| Logistics department | 18 | 47,4% |
| Sales department/Marketing department | 14 | 36,8% |
| Director/President of the Managing Board | 11 | 28,9% |
| Managing Board | 1 | 2,6% |
| Finance department | 1 | 2,6% |

The data in Table 7 indicate the percentage of different logistics activities outsourced by responding organizations. Approximately one-third of the responding organizations outsource either two or three logistics activities, while fewer than 10 percent of the responding organizations outsource one logistics activities. The most frequently outsourced activity (92,1 percent of respondents) is “road transport”, followed by “customs broking” (44,7 percent of respondents) and “distribution” (39,5 percent of respondents). In 18,4 percent of cases, Slovenian respondents outsourced “warehousing”, while product marking, labelling and packaging is outsourced by 13,2 percent of respondents.

Table 7: The most often outsourced logistical services by Slovenian companies

| **Outsourced logistical activities** | **Frequency** | **(%)** |
|---|---|---|
| Road transport | 35 | 92,1% |
| Customs broking | 17 | 44,7% |
| Distribution | 15 | 39,5% |
| Warehousing | 7 | 18,4% |
| Product marking, labelling, and packaging | 5 | 13,2% |

## 4. CONCLUSION

This paper also expands previous research on logistics functional processes and logistics outsourcing on the Slovenian market.

There are several implications of these findings for logistics management. Results indicate that have different business strategies of entrance on foreign markets across countries can contributed to the development of different marketing strategies for those market segments. And also, the effectiveness of entire logistical function depends upon which logistics provider use. The logistics marketplace is highly competitive, and thus

suggests that managers are involved in selection of logistics provider. Furthermore, outsourcing plays an essential role in the logistics industry. The survey identified the following as significant outsourcing functions: road transport, customs broking, distribution, warehousing, product marking, labelling, and packaging.

Because of the differences across companies in selected business strategy in foreign market entry, we conclude that managers should develop different marketing strategies for entrance on foreign markets across industries. A better understanding of entire logistics function from the planning, through implementation and control in the sample of Slovenian companies, would contribute to business organizations in the field of logistic industry.

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# POSSIBILITIES OF USING THE ADVANCED LOGISTICS SYSTEMS IN REPUBLIC OF SERBIA

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***Abstract***

Logistics includes diferent business activities of all enterprises, as well as other entities of the social structure, which are focused on efficiently organizing the flow of products and services from point of delivery to the place of its reception. Throughout the history, it has evolved from the traditional traffic management to the multidisciplinary scientific field. In addition to its significant penetration in the military sector, the application of logistics has expanded to all areas of civil society.

Logistics is conceived of several key activities (transportation, structures of supporting facilities, inventory management, materials handling, communication). Logistics is a system of interdependent elements. Logistics systems can be established at different levels and in different economic sectors, with the main task focused on improvement of effectiveness and efficiency in realization of product and service flows. In order to optimize these flows, companies are developing and applying modern technological solutions, based on their business concepts.

In such market conditions, companies are faced with increasingly demanding customers and it organize their logistics operations in accordance with the principles of "drawing" strategy. Despite the many benefits that this strategy offers, its application at Serbian market faces numerous difficulties, which are manifested itself through weak logistical and technical support, lack of willingness of commercial actors in establishing long term business relationships in the B2B market.

***Keywords:*** logistics systems, production flow, PULL strategy, PUSH strategy

## 1. INTRODUCTION

The application of technological innovation in various business processes is changing basement for establishing relationships between companies in the supply chain. Implementation of modern business systems in the production process, in particular distribution, has resulted in efficient adjustment offers to customers and elimination of some functions of intermediaries. Information technology has created a revolution in the communication system between all stakeholders in the supply chain.

Through influence of the technological and information development, as well as other market factors, behavior of the final and institutional customers is modifying. Unlike traditional relations of exchange process, where buyers have passive role as payers, in modern market conditions, buyers needs and requirements are the initial point of all business processes (Center, 2010). Therefore, buyers actively participate in the process of value creation, with a totally new forms of exchange, based on establishing of long-term relationships.

Greater buyers power and lower transaction costs, in relation with reduced life-cycle of products and services, further are aggravating the position of bidders during the introduction of new products to the market. Regarding to influence of these factors, the demand becomes more uncertain, while supply is frequently changing and adapting to new requirements. In such market conditions, traditional logistics systems are not able to provide adequate support to the implementation of business processes in the supply chain, which is the reason of establishment of new logistics concepts based on the application of the "drawing"strategy ("pull" strategy) and development of long-term relationships in the B2B market. With its implementation in most developed markets, large business systems realized numerous benefits in the form of lower transaction costs, enhanced coordination, more effective information exchange, shorter delivery time and increased customer satisfaction (Prior, 2007).

## 2. SYSTEM APPROACH TO LOGISTICS CONCEPT

Logistics as a separate activity has developed in parallel with development of human civilization. It played significant role in organization of great people migrations and numerous wars. Logistics in modern market conditions has grown into a young scientific discipline which is used in almost all areas of human endeavor. It can be defined as a set of planned, coordinated and controlled intangible activities through which are functionally combined all partial processes to overcome spatial and temporal transformation of materials, semi-finished products, knowledge, capital, people and information in a rational, unified logistics processes and flows, from the sender (point of delivery) to the receiver (point of receipt), through aim focused on how to maximize satisfaction of market demands with minimum invested potentials and resources (Zelenika & Pupavac, 2008). It consists of five primary activities (Bloomberg, 2002):

- transport - transfer of products from the point of delivery to the point of receiving through various forms of transport (road, air, water, rail and pipeline);
- structure of supporting facilities - strategic setting of warehouses and logistics centers and making decisions regarding to its number, types, and operations;
- inventory management - inventory management of raw materials, semi-finished goods and finished products and goods through marketing channels;

- handling of material - the effective and efficient transfer and packaging products;
- communication - information exchange within supply chain.

All these activities contribute to creation of additional space and time value by reducing costs and increasing product quality. Its mutual influence and connectedness, has influence on essence of logistics concept which is reflected on implementation of system-theoretical approach to study of different logistics phenomena (Roca, 2004). Thus, logistics can be represented as a system of interconnected compatible, complex, stochastic and dynamic elements (subsystems). In recognition of functional relationships between logistics elements, it should be also considered efficiency and optimization of overall logistics system.

In global, macro and micro economic systems exist numerous special logistics (sub) systems, which are operation at different levels, more or less successfully, efficiently and rationally and produce special kinds of logistic products. The most important (sub)systems are (Regodić, 2009): megalogistics system, global logistics system, macro - meta - micro logistics system, interlogistics and intralogistics systems, system of logistics services, information logistics systems, logistics management system and logistics system of sustainable development.

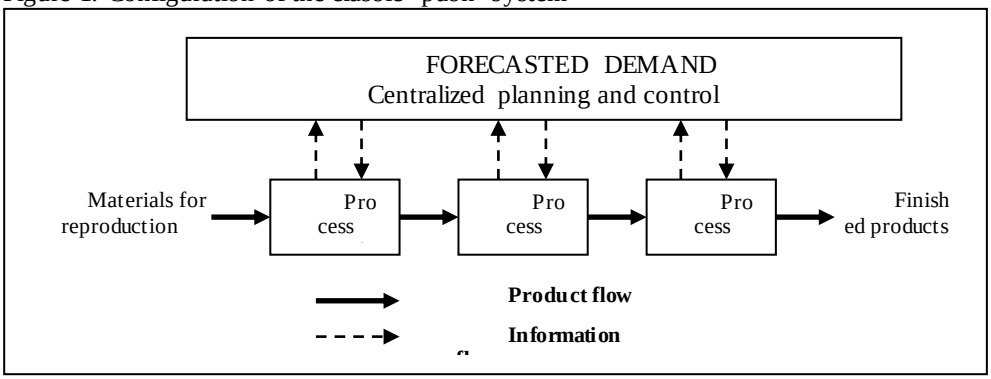
Unlike from mega, macro and global logistics which are related to planetary logistics phenomena, global and national dimensions, micrologistics system represents set of logistics activities, knowledge and resources focused on the efficient and effective achievement of company objectives. It consists of logistics of production, trade and service companies (Kalinic et al, 2009). Depending on various activity and business conditions, companies can in cooperation with its business partners, organize product and information flows through "push" or "pull" logistics systems.

### 2.1. Logical systems based on the "push" strategy

In order to optimize production flow and efficient allocation of resources, from 1970s of the twentieth century in the United States, companies implement new logistics system, based on the use of modern technological advances. Among these systems particular place have production planning systems ("MRP I" and "MRP II" systems) and distribution needs ("DRP"). Both of these concepts are applied in accordance with principles of "push" strategy.

Basic premise for application of "push" system is reflected at possibility of more precise demand forecasting. Anticipated data on demand are representing starting point for organizing all other activities in the supply chain (it defines the necessary procedures and resources, it procured the necessary equipment and trained personnel; it implements production and distribution activities and controls all business processes and correct possible deviations) (Hagel & Brown, 2008). Figure no. 1 represents configuration of product flow in "push" system.

Figure 1. Configuration of the classic "push" system




Source: Klaas, 2009.

Set on the principals of „push" strategy, the Material requirements planinig system (MRP I) is used for efficient production organization process and for the supply of neccesery material resources, according to forecasted buyers orders. Its implementation depends on the sofistication of software solutions, used by supply chain participants. Main steps of MRP I system are the following (Bloomberg, 2002):

- demand forecast,
- production schedule (defining of required amount of products and time of delivery to customers),
- identification of materials and semi-finished productsl in production process and classifying it according to importance and time of use,
- monitoring of stock levels,
- issuing of orders to suppliers,
- monitoring and preparation of reports about delivery realization.

In addition to organization of internal products flow, it is important to define manufacturing and financial capacities (equipment, staff and financial), which are necessary for its implementation. For preparation of operational and financial plans, companies use special system of "planning production potential" ("MRP II" system), which is upgraded "MRP I" system.

"Push" strategy principles also have influence on organization of product flow from production to distribution centers and customers. In this case, system of "distribution requirements planning" ("DRP" system) is applied. Implementation of "DRP" system ensures greater product availability and shorter delivery time to customers.

"Push" logistics systems are primarily focused on increasing of production flow efficiency. It is based on established planed procedures, defined according to demand forecasts. However, regarding to numerous factors makes which makes forecasting and anticipation of customer response difficult, companies are increasingly implementing logistics systems which are adapted to new, changed market conditions.

### 2.2. Logical systems based on the "pull" strategy

If companies want to meet customer needs and achieve desired business results, it must consider all market changes and be adapted to new market conditions. Various factors have influence on changing of way of managing production flow. Traditional logistics

"push" systems are increasingly replaced by modern integrated concepts, which are based on implementation of "drawing" strategy ("pull" strategy). Implementation of these systems will eventually become a necessity regarding to market trends, and not only for development but also for survival of companies in some sectors. Many companies ignore the fact that future has arrived, no matter what it is unevenly distributed. Table no. 1 presents main characteristics of "pull" system.

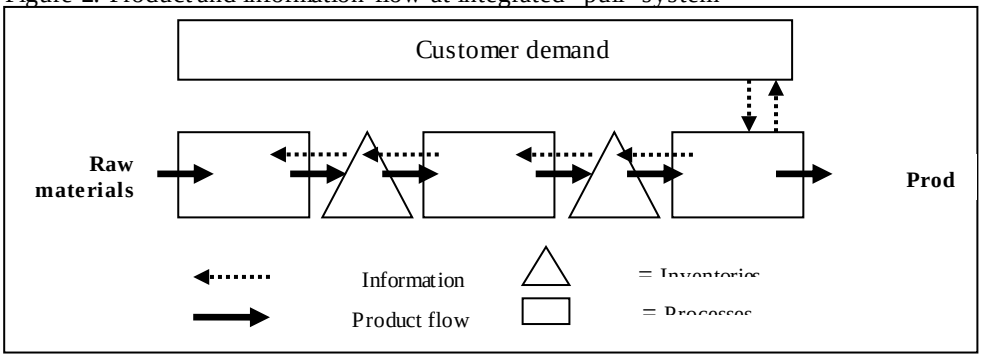
Table 1. Characteristics of „push" and „pull" systems

| **„Push" system** | **„Pull" system** |
|---|---|
| Demand can be predicted | Demand is uncertain |
| Planning a "top-down" | The integrated approach |
| Centralized control | Decentralized initiatives |
| The procedural approach | The modular approach |
| The orientation on resources | The orientation on people |
| Inability participation | Willingness to participate |
| Focus on efficiency | Focus on innovation |
| Limited innovation | Encouraging innovation |

Source: (Hagel & Brown, 2008.)

"Pull" logistics systems appear as a response to growing uncertainty in business. Its implementation does not seek to eliminate market "tension" but to find creative solutions which can meet the customer needs. Unlike the traditional approach, where success of business equals to dynamic stability, predictability and regularity, in modern logistic systems success can be reached through the process of continuous learning, changing and creating new constellations and compliance division (Roca, 2002). In such circumstances, there is a creative tension that points all employees to do the research and critical review of existing practices. Instead of centralized control system and compliance with pre-defined procedures, "pull" logistics system features modular approach of organizing activities in which are involved other members of the supply chain. Company cooperates with its partners, and it is trying to take advantage of opportunities, which can bring some uncertainty. It creates a custom value to customers through interdependent integrated process. The following figure represents the product and information flow in "pull" system.

Figure 2. Product and information flow at integrated "pull" system




Source: (Klaas, 2009.)

As the Internet represents fertile ground for implementation of various innovative solutions, integrated "pull" logistics systems are mostly implemented on Internet market. Technology development, followed by digitization process, is significantly contributing to it. Instead of waiting for producers to offer and deliver ready compilation, customers across specific web sites can also choose ("pull") songs and make the adequate solutions (Hagel & Brown, 2008). New form of distribution based on "drawing" strategy, has forced many companies (operating in the electronic market) to offer range of tools to their customers, which help them to get the desired product or service easier and faster. Customers are actively involved in value creation process and continuous exchange of information with suppliers. In addition digitized solutions, logistical "pull" systems can be used in the production and distribution of conventional, natural products, as well as in other sectors. Large numbers of companies in Europe and United States, which are engaged in production and sales of consumer goods, clothing, motor vehicles and computers have implemented integrated "pull" systems.

At the end of twentieth century, commercial actors (retailers and their suppliers), launched numerous initiatives related to potential reduce of operating costs in the supply chain through coordination of logistics activities and implementation of integrated logistics systems. Among these initiatives, the most significant is "efficient consumer response" (ECR) and system of "collaborative planning, forecasting and supply" (CPFR). Both concepts are based on "pull" logistics systems use, data sharing and establishment of partnerships in the supply chain.

## 3. APPLICATION OF «PUSH» LOGISTICS SYSTEMS IN THE REPUBLIC OF SERBIA

For the successful implementation of modern, integrated, logistics systems, it is necessary to create an appropriate business environment that will enable companies to realize products and information flow more effectively. It is necessary to (Zelenika & Pupavac, 2008; Lovreta, 2009):

- Provide adequate logistical support,
- Achieve appropriate level of cooperation and trust between the partners,
- Provide adequate technological and informational support.

Logistics as instrument of economic development, offers specific solutions, which in a relatively short period of time can provide greater economic efficiency. Therefore, it is not a small problem that analysis of the overall economic situation in Republic of Serbia shows insufficient knowledge of real possibilities of development, which is resulting from inadequate application of basic management principles and modalities of product flows. Unlike from Germany and Hungary, where logistics is declared the third (in Germany) and sixth (in Hungary) economic branch, in Serbia it is completely neglected. This can be confirmed through World Bank report for 2010. in which Serbia took 83 place out of 155 countries in comparation of value of logistics performance index - LPI (Arvis, 2010). Lower LPI index compared to Serbia have only neighboring countries Bosnia and Herzegovina, Albania and Montenegro. Consequences of this situation are numerous and it has full negative reflection on application of modern business concepts, on which basis it could formed new integrated logistics systems. New integrated logistics systems can eliminate the unsafe, inefficient and slow managing of material goods flows.

However, unlike to most developed countries, Republic of Serbia is mostly dominated by the traditional business conditions, where buyers and sellers, driven by their own interests, seek to find way for shortest time to maximize its benefits. These companies conclude its business arrangements with focus on short-term interests, with minimal transaction costs. In such circumstances, members of supply chain are focused on bargaining over the achieved profit (Levy & Weitz, 2009). Table no. 2 represents critical factors of cooperation in "B2B" market, which are judged by companies operating at Republic of Serbia market (scores of 1-3).

Table 2. The main factors of cooperation in the Republic of Serbia business market

| Item no. | Factor | Score |
|---|---|---|
| 1. | Prices and margins | 2.97 |
| 2. | Continuity of supply | 2.96 |
| 3. | Quality of supply / range | 2.93 |
| 4. | Professionalism | 2.93 |
| 5. | Exactness | 2.90 |
| 6. | Delivery Schedule | 2.86 |
| 7. | Long-term partnership | 2.76 |
| 8. | Exchange of information | 2.75 |
| 9. | Possibility of return of goods | 2.72 |
| 10. | Customization offers | 2.71 |

Source: (Lovreta, 2009)

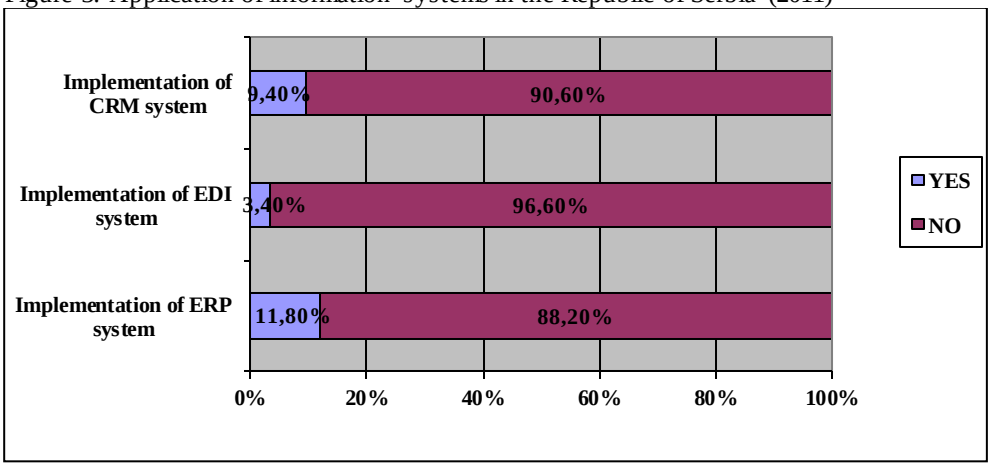
Best evaluated criteria are related to the offer price aspect, continuity of supply and quality product range. On the other hand, criteria related to the long-term partnerships, such as information exchange, return of goods and adaptation of supply, are less marked.

In integrated logistics systems, special attention is oriented to modern technology and information solutions. Its application should provide adequate information support to production flow from initial supplier to the consumer basket. Also, it provides a significant support in decision-making process and it increases efficiency and transparency of transactions, both within the company and between business partners. Through implementation of "ERP" and "EDI" system, functional (internal) and intra-organizational (external) connections can be established, and it facilitates the implementation of business processes and common goals of the company. In addition to these two systems, in order to optimize business processes and creating customer-driven values, supply chain subjects use many different software solutions, including "SCM" and "CRM" systems[7]. However, application of modern technological advances, including "ERP" and "EDI" information system in the Republic of Serbia is at very low level. From 98.7% of the companies in which computers are used in business purposes, just 11.8% of them use "ERP" software package to share information on sales and/or supply with other internal departments (finance, marketing, manufacturing, etc.). During 2011, only 9.4% of companies used some of the software application for managing information about clients ("CRM"), while "EDI"

[7] "SCM" software system can be used as an information support in the supply chain processes, while the use of "CRM" software solution allows client to create a database of customers, to realize personalization of customers, to increase monitoring and value-added goods, as well as interaction with customers after the purchase (service and customer service assisting customers, known as help Desk).

information system has been used to receive orders for products or services by 3.4% companies.

Figure 3. Application of information systems in the Republic of Serbia (2011)




Source: Statistical Office of the Republic of Serbia, 2012.

Neglect of the logistics sector, insufficient level of trust and cooperation between business partners and inadequate information support are main difficulties in implementation of integrated, logistics systems. Therefore, we can conclude that application of modern logistics systems is not simple in Serbian market.

## 4. CONCLUSION

Logistics in the early period of 20$^{th}$ century has developed very quickly and it established itself in various economic fields, in broader and more subtle meaning, especially as an interdisciplinary and multidisciplinary science. Its main task lies in overcoming the spatial and temporal transformations of materials, semi-finished products, knowledge, capital, people and information in rational, unified logistics processes and flows.

In order to optimize of products and information flows at some economic areas, various logistical concepts can be applied. Globalization processes, technological development, growing competition and increasingly demanding consumers, have influence on establishment of new logistics system, based on a "drawing"strategy. In contrast to the "push" strategy, „pull“ strategy is designed as modern, business concept focused on customer whose needs are "pulling" all other activities in the supply chain.

Despite numerous benefits of pull strategy implementation such as lower transaction costs, enhanced coordination, more efficient information exchange, short delivery time and increased customer satisfaction by implementing modern logistics system, it faces with number of difficulties in the Republic of Serbia. Underdevelopment of infrastructure systems, particularly in transportation area, lack of knowledge and even more limited experience, neglecting the logistics sector, insufficient level of trust and cooperation between business partners and inadequate information support are just some of them.

One possible way to overcome the current situation and to establish of modern logistics system in Serbia is related to the improvement of the logistics sector through the announced modernization of transport infrastructure and construction of logistics centers. Development and application of modern transport technology is one of the primary conditions for the inclusion of the Serbian economy in the European exchange of goods. Also, the implementation of these technologies significantly increase the quality of service delivery and efficiency of the entire transportation system. Therefore, it can be expected future arrivals of large business system, in addition to the state sector, can also greatly contribute to the further development and improvement of the Serbian logistics sector.

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# MEASUREMENTS WITH TRAFFIC COUNTER IN CITY LOGISTICS IN LJUBLJANA

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***Abstract***

City supply is one of the most highlighted topics in modern logistics. The main goal of research activities is consolidation and reduction of transport needs, lowering energy consumption, air and noise pollution, etc. The goal of our Tracy R&D Project is to invent an appropriate, flexible and low-cost traffic counter tool to support scientific research, decision making process and evaluation of actions made by city authorities. In our essay we present a possible application of Tracy tool in the Slovenian capital.

**Keywords:** City supply, traffic counting, measure

## 1. IMPORTANCE OF THE TRAFFIC VOLUME IN CITY LOGISTIC

There are many topics appearing in the scientific literature related to city logistics research like efficient supply chain, improved infrastructure and reduced logistics costs. Topic of economy and feasibility means growth in service, sector attract, investments and new jobs. Topic of urbanization covers efficient and reliable supply and sustainability. The topic of traffic means less trucks, lower congestion, intelligent routing and higher truck

utilization and the final topic, environment, covers improvement of life quality, noise reduction and air quality improvement.

Taniguchi et al. defined City Logistics as "the process for totally optimising the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy." (Taniguchi et al., 1999) (Taniguchi et al., 2001)

Reference (Benjelloun & Crainic, 2009) said that City Logistics aims to reduce the nuisances associated to freight transportation while supporting the sustainable development of urban areas. It proceeds generally through the coordination of shippers, carriers, and movements, and the consolidation of loads of different customers and carriers into the same environment-friendly vehicles.

Most authors describe city logistics in the frame of transportation or freight delivery. Reference (Dizan et al, 2012) stated that logistics is vital to the life of cities and their residents. It is a major provider of wealth and a source of employment. Large logistics facilities, serving increasingly national and international markets have become a crucial element of dynamic metropolitan economies.

The next definition that comes really close to what we are researching was stated by Reference (Awasthi & Chauhan, 2012). It says that "City logistics is that part of the supply chain process that plans, implements, and controls the flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customer's requirements''. The logistics associated with consolidation, transportation, and distribution of goods in cities is called city logistics. From a systems point of view, city logistics consists of many subsystems involving different stakeholders namely shippers, receivers, end consumers, transport operators and public administrators. The end-consumers are residents or the people who live and work in the metropolitan areas. Shippers (whole-salers) supply good to the receivers (retailers, shopkeepers) through transport operators (or carriers). Administrators represent the government or transport authorities whose objective is to resolve conflict between city logistics actors, while facilitating sustainable development of urban areas.

The existing studies on city logistics planning can be mainly classified into (a) survey based approaches, (b) simulation based approaches, (c) multicriteria decision making based approaches, (d) heuristics based approaches and (e) cost-benefit analysis based approaches (Awasthi & Chauhan, 2012).

In our paper, we are going to pay attention on traffic point of view and research. As Reference (Ehmke et al, 2012) stated, city logistics is about routing and scheduling logistics operations in urban areas. Concerning transportation, it seeks for approaches allowing for fast, accurate and reliable pickup and delivery operations as conducted by parcel services or waste disposal services. Nowadays, city logistics service providers have to consider dynamics within logistics processes, e.g., shorter delivery times, higher schedule reliability and delivery flexibility. Furthermore, service providers compete against other road users for the scarce traffic space of inner cities. In conurbanisations, traffic infrastructure is regularly used to capacity.

Realistic travel time estimations for the links of the traffic network are one of the most crucial factors for the quality of routing, since travel times in road networks heavily depend on network load, Network loads in urban areas are highly fluctuant with respect to different network links and times of the day, resulting in traffic jams. Hence, city logistics routing cannot rely on mere travel distances. For the most part, a single travel time value per link, as provided by today's digital roadmaps, only insufficiently represents the traffic situation.

City logistics routing requires time-dependent travel times capturing load fluctuations for each network link (Ehmke et al, 2012).

Travel time determination is a long established field of research. Traditionally, travel times have primarily been of interest in the context of modelling traffic flows and quality. The process of travel time determination consists of two basic steps. First, traffic flow data is collected empirically. Then, the collected data samples are analyzed and extrapolated in terms of traffic flow models providing travel times. The collection of traffic flow data is usually carried out by stationary sensors or by manual short-time census. Traffic flows in urban road networks are highly fluctuant with respect to different network links, times of the day and day of the week. In order to derive travel times for city logistics, area-wide data collection is necessary (Ehmke et al, 2012).

Data analysis is usually carried out by parameterizing data flow models by collected data samples, resulting in sped-flow diagrams or daily curves of traffic flows. However, traffic flows on urban main streets are subject to a large variety of influences leading to modelling obstacles. A detailed reconstruction of travel times from traffic flow samples is complex. In sum, the provision of reliable travel times for city logistics routing is a challenging taskand valid approaches are rare (Ehmke et al, 2012).

## 2. THE ANDROID BASED APPLICATION: TRACY

The measurement is an essential part of the modelling and simulation process, what makes us possible to realize problems and bottlenecks, to generate input parameters and to validate the designed simulation model.

Although measurement and monitoring has a key role in the innovation process these activities usually got only little interest. Many possible solutions are available from in-built recognition systems and video-observation to the paper-based hand-writing applications. The widely used traffic counter systems and methods have many disadvantages, like time demand of the data digitalization or huge installation cost.

We developed the Tracy System in Szabó-Szoba R&D Laboratory, Győr under the Android platform, running on tablets or smart phones. The goal was to develop an innovative traffic counter system, which is able to replace the old paper based systems. The data collection is much more exact and processing of data is easier. There are no special logistics skills required by the observers, but on the other hand the application is powerful enough to have the capacity of gathering sufficient data in the real time window.

The application is flexible and modular, as a result we can measure different vehicles with different focus, different places, and special measures (like how many people are in the car, or the cyclist wear a helmet or not, etc). The system save all the data with time stamp, as a result we can analyze the time distribution of traffic, and listen the voice file recorder by the application. On this way it is possible to make audio-comments related to unpredictable events during the measurement. With this system we can see the time periods between the vehicles and we can follow the daily traffic distribution.

Data gathered with Tracy can be used for different purposes such as recognizing the traffic flow on different points, crossroad's load and maximum capacity of vehicles on a certain road.

Figure 1: TRACY screen

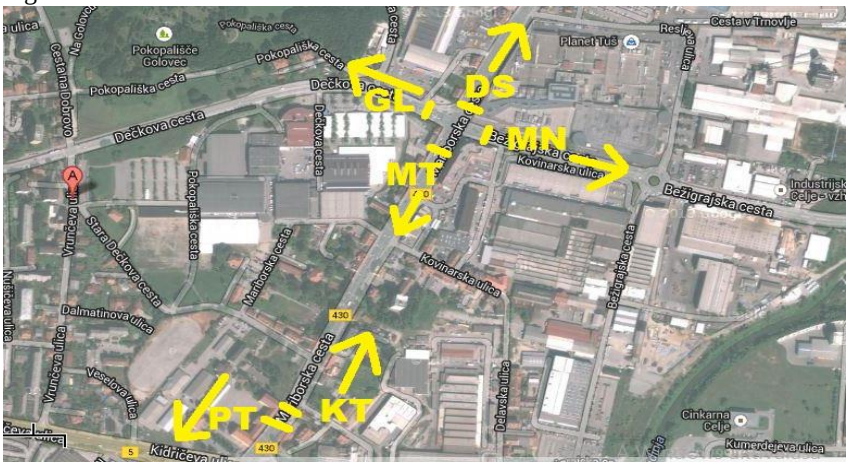

Source: (Hodosi et al., 2013)

## 3. CASE STUDY: CELJE, LJUBLJANA SLOVENIA

Case study of Celje was made for the purposes of the test one of the new invention of the laboratory. The idea or the main problem in the city of Celje is a number of delivery vehicles in the city centre, next to the mall, route between the highway and city centre.

The test environment was chosen by a local experience about a critical intersection. On this road our hypothesis was that we will able to show the traffic distribution from the data of the vehicles which leave the intersection, that is the reason why we measured from different directions.

Figure 2: Observers on the road

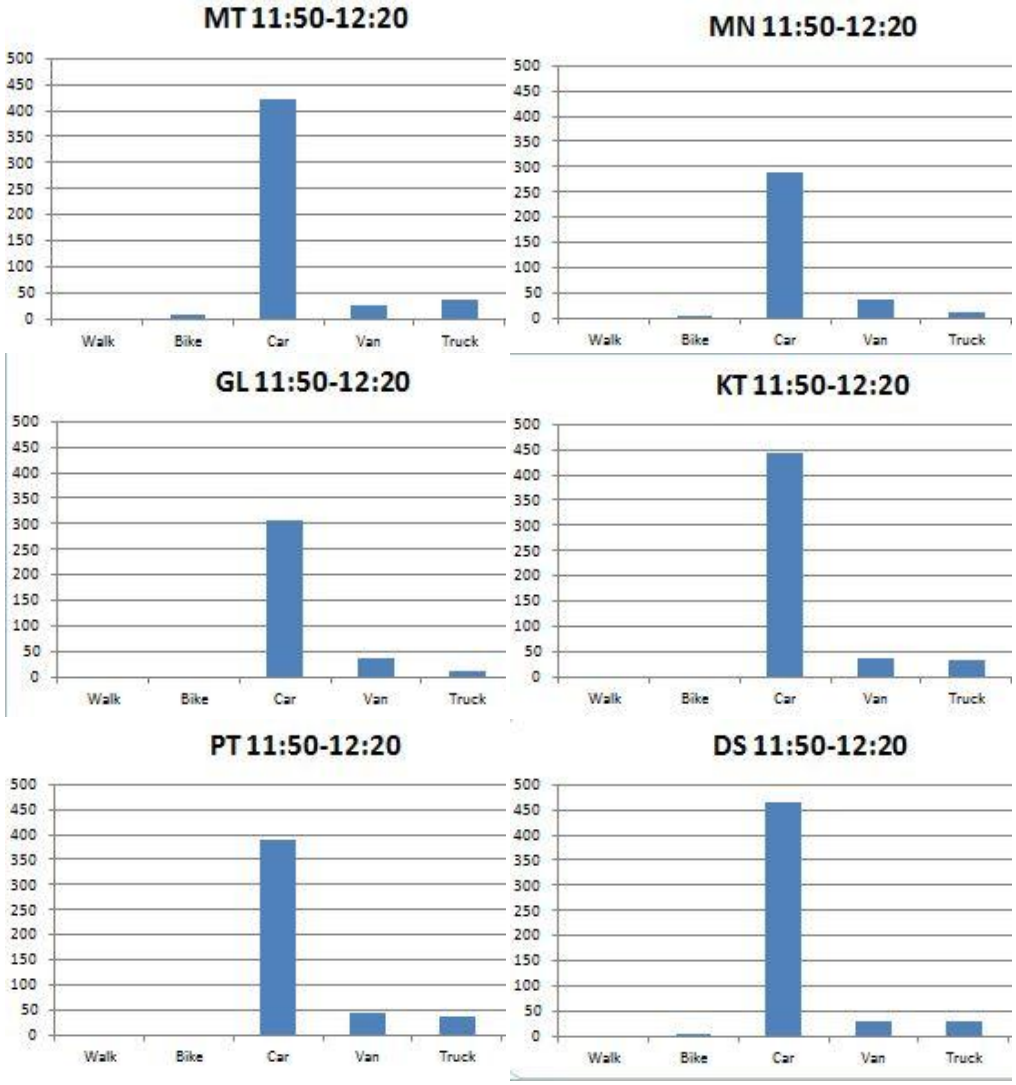



Source: Google Maps, [available at: http://maps.google.com acess: 15.09.2013], own editing

The test started with observation and then measure on the road and in the intersection. The test measurement was held through 30 minutes, started from 11:50 and finished at 12:20. The weather conditions were sunny and clear, and the date was 22nd of may, 2013. Every point were measured only one direction not one lane, as it has shown on Fig 2.

The data what we got, shows that we can count the traffic distribution for an intersection from the data of the vehicles which leave the crossroad.

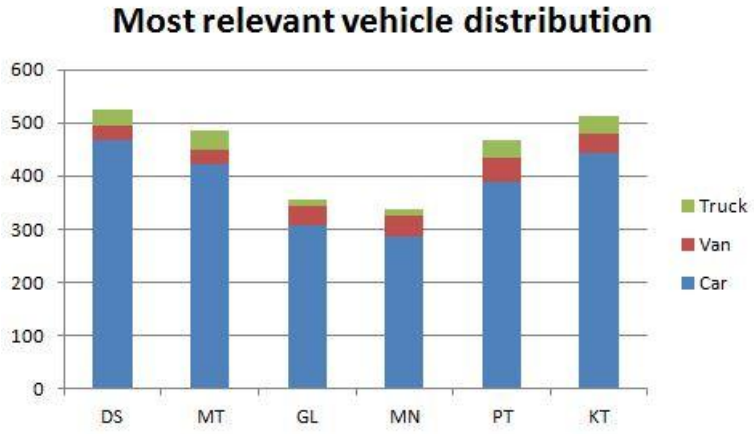
Figure 3: All vehicle distribution on each measured point.




Source: own study

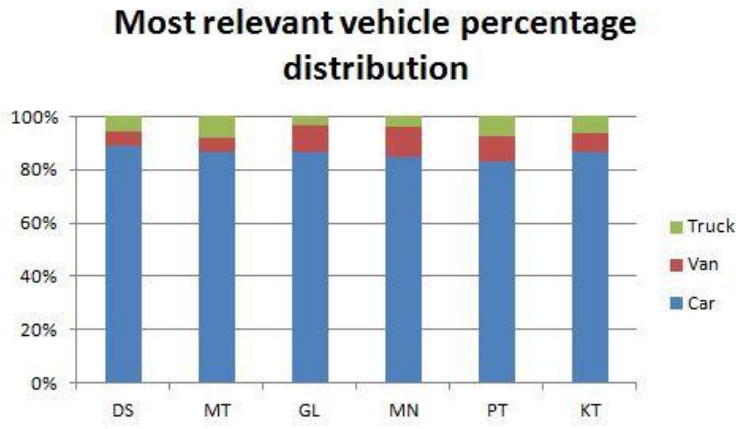
We also collected the 3 most relevant types of vehicles in our case. Which are the cars, vans and trucks.

Figure 4: Most relevant vehicle distribution




Source: own study

Figure 5: Most relevant vehicle distribution in percentage




Source: own study

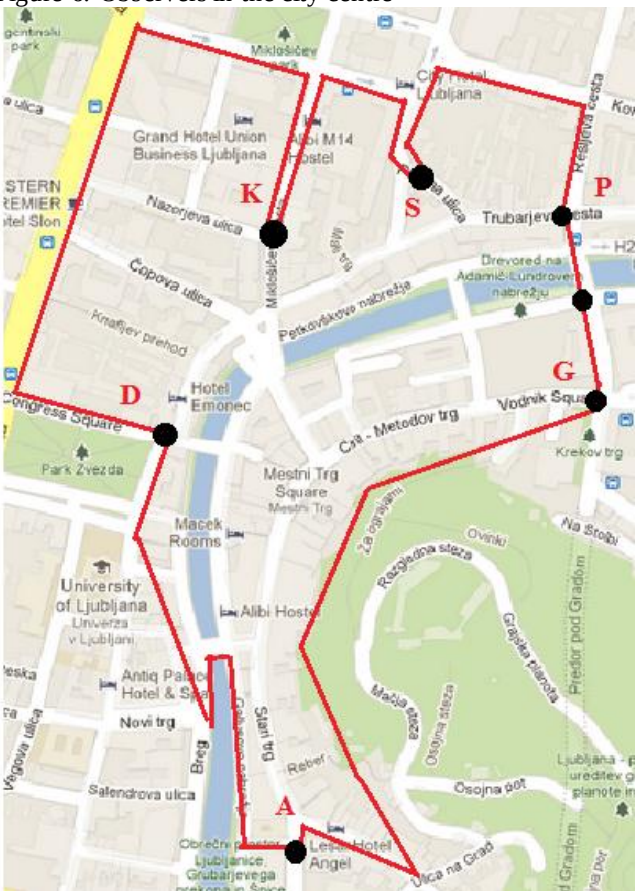
We can conclude that most of the trucks are going to the city centre from the highway or back and most of the vans are heading on the parallel road with the highway.

Case study of Ljubljana was made for the purposes of the diploma thesis of one of the members of the laboratory. The idea or the main problem in the city of Ljubljana is a number of delivery vehicles in the city centre itself.

We developed few possible ideas or solutions about the delivery in the centre of Ljubljana. For that purpose, we intended to test our hypothesis about the number of vehicles going to the city centre and to simulate the traffic flow in the time dimensions and the number of different vehicle types. In this chapter we can see the Ljubljana measurement time distributions, using the Tracy app.

Their vehicles enter the centre quite frequently during the week and there are also a few vehicles entering that are taking care about maintenance. Mail is delivered with bikes or motorcycles (in Tracy, we put bikes and motorcycles as one type of transport), but we should add that the large packages are still delivered by cars or small vans. Delivery to the stores or restaurants is held by different (logistics) companies or owners of the places, which means, that there are cars or vans driving into the city centre. As we can see, regarding to the politics of the city centre that this should be pedestrian-only area, there is still a lot of traffic involved (Hodosi et al., 2013).

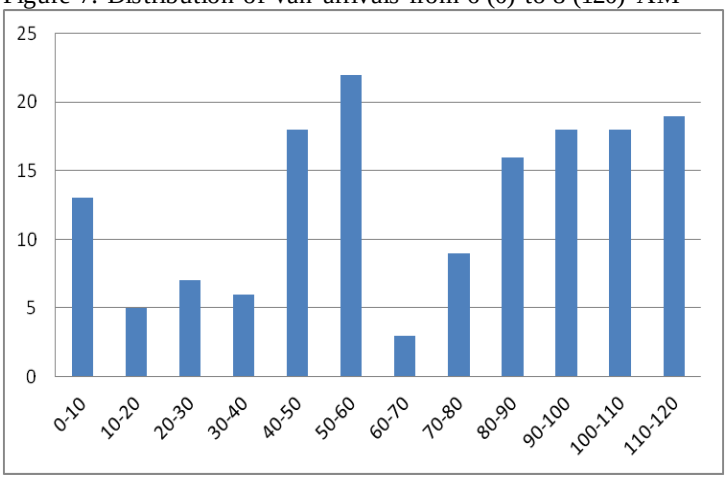
Figure 6: Observers in the city centre




Source: (Hodosi et al., 2013)

Next step was the measurement of the vehicles entering the city centre. With these measurements we wanted to test the hypothesis mentioned above and to gather sufficient data to propose possible solutions. Measurement was made in the morning, from 6.00 AM to 8:00 AM because that is the time of the delivery peak. We measured the incoming traffic on 7 different measuring points, for which we know from personal experience, drivers use for the entry into the city centre to make deliveries. We put our focus in this case only for van distribution.

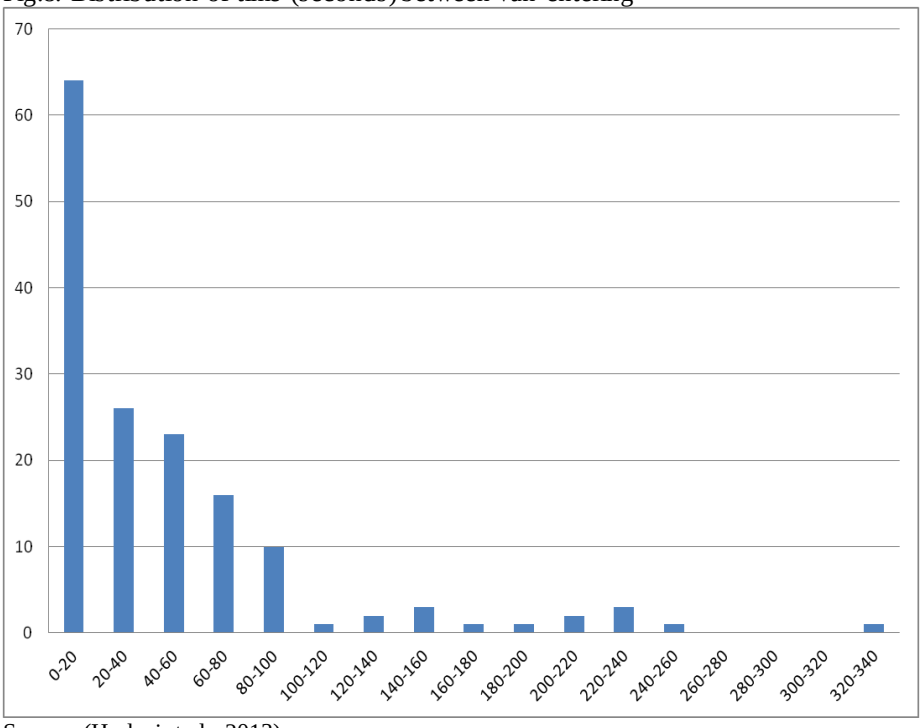
Figure 7: Distribution of Van arrivals from 6 (0) to 8 (120) AM




Source: (Hodosi et al., 2013)

Considering congestion and waiting time problems a lot depends on the arrival time of the delivery vehicles. As can be seen there is a gap between 6 and 7 (10-40 minutes) and the constant 15-20 vehicles / 10 minutes level arrive after 7:30.

Fig.8. Distribution of time (seconds) between Van entering




Source: (Hodosi et al., 2013)

What is more, we should focus on the time distribution between the vehicles entering into the city centre. In the rush hours more than 60 arrivals are in less than 20 seconds after each other (cumulative data, all entering points included) In spite of the fact that there was no serious congestion during the measurement we can highlight the need for city supply planning and re-designing discussion (Hodosi et al., 2013).

## 4. CONCLUSION

In our essay we presented the Tracy traffic counter monitoring tool we developed in Szabó-Szoba Laboratory, Győr Hungary. There is a real need to measure and analyze the traffic flow in city centres or focus for only a route, intersection or only for special type of vehicles and specifications as We illustrated on the example of Ljubljana city centre measurement case study. The Tracy system is a flexible and adoptable frame for further research and evaluation. Based on the measurements we opened some questions to discuss, like: How can we eliminate the traffic (vehicles such as vans, cars, etc.) in the city centre? What are the real alternatives for consolidation of goods in city supply? How can we reduce the level of carbon footprint? How can we use sustainable transport methods as alternative solutions due to environmental and noise pollution? In the frame of our further research we will develop the plotting board model of special city supply environments from different European countries and model the effect of innovative delivery methods.

The TRACY application family under continous development, to cover every field of traffic measurements.

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# THE NEW COMPUTERIZED TRANSIT SYSTEM AND E-CUSTOMS INFLUENCE ON SAVINGS IN TRANSIT TIME AND COSTS

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***Abstract***

E-customs is dramatically changing the role of customs offices and international forwarders. E-customs comprises from different activities which are used for a safe exchange of goods, services and information using computers and modern information and communication technologies. New e-Customs system is based on new customs procedures and tax system as well as new commerce and statistics regulation in Croatia. The New Computerized Transit System (NCTS) is one of the first e-Customs tools which is implemented in Croatian customs service during Croatian preparations to enter the European Union.

Implementation of New Computerized Transit System) is step into new way of doing customs procedure which represents continuation of common work of customs offices, international forwarders and entrepreneurs in order to create condition for better, faster and more efficient flow of goods. The NCTS has several advantages for customs office, entrepreneurs and especially for forwarders, authorized importers and exporters, transporters and all other members of transportation.

Usage of the NCTS helps entrepreneurs to shorten the transit time from Croatian border to the final destination; it shortens waiting at the border and therefore creates savings in transit time; saves money for preparation of customs documentation at the border; enables better, faster and more professional work related to the procedure of transportation of goods.

**Keywords:** e-Custom, NCTS - New Computerized Transit System, transit time, savings

## 1. INTRODUCTION

Customs was always part of country's history and custom's history is identified in special way through political, economic, social and cultural events. It is also a reflection of country's development with influences deriving from economical, legal and social development. In its traditional role, Custom is seen as a keeper of the gates on country's borders. Horvat (2011) noted that, in this way, customs was always country service for collecting customs excise duties. The traditional role of customs is changing recently, due to developments in the international supply chain processes which, among other, include (Gordhan, 2007):

- The growth of international trade,
- Reduced tariff and non-tariff barriers,

- New models of logistics and the supply chain,
- Increasing use of the information and communication technology (ICT) in international trade operations.

Previously mentioned developments are pressuring customs administration to update their models of operation (Gordhan, 2007; Widdowson, 2007). Today's customs administration is in the middle of globalization process. Therefore customs is the key factor for competitiveness of companies and countries in relation to its duties in controlling international trade. Wilmott (2007) stated that the use of an information and communication technology will enable more automated processes, which will increase the efficiency and reduce the need for manual re-entries and validation of the same data. Raus et al (2009) concluded that a public sector can have an advantage of faster delivery of its services to companies and can achieve a financial savings related to the time savings.

Development of new relationships in a society and changes in the way of conducting business will increase the importance of customs authorities as a country service which has to ensure the highest quality and easily accessible services. Horvat (2011) noted that this is particularly outlined today because customs and excise operations are almost unthinkable without the use of ICT.

## 2. E-CUSTOMS AND NEW COMPUTERIZED TRANSIT SYSTEM

The European Parliament has defined competence of Customs in European Union in a following way: "*Customs authorities shall be primarily responsible for the supervision of the Union's international trade, thereby contributing to fair and open trade, to the implementation of the external aspects of the internal market, of the common trade policy and of the other common Union policies having a bearing on trade, and to overall supply chain security. Customs authorities shall put in place measures aimed, in particular, at the following: protecting the financial interests of the Union and its Member States; protecting the Union from unfair and illegal trade while supporting legitimate business activity; Ensuring the security and safety of the Union and its residents, and the protection of the environment, where appropriate in close cooperation with other authorities; maintaining a proper balance between customs controls and facilitation of legitimate trade.*"[8]

The European Union (EU) administration is investing efforts and placing initiatives in order to facilitate legitimate trade using IT, and to improve and simplify the laws and regulations, which are not sufficiently, clear, precise and therefore difficult to be successfully implemented. Therefore the EU administration has increased a demand for faster and more efficient customs clearance. Traditionally the most important customs task is the collection of customs duties, part of the value added tax (VAT) and excise taxes, as well as the implementation of legislation for implementation of customs procedures.

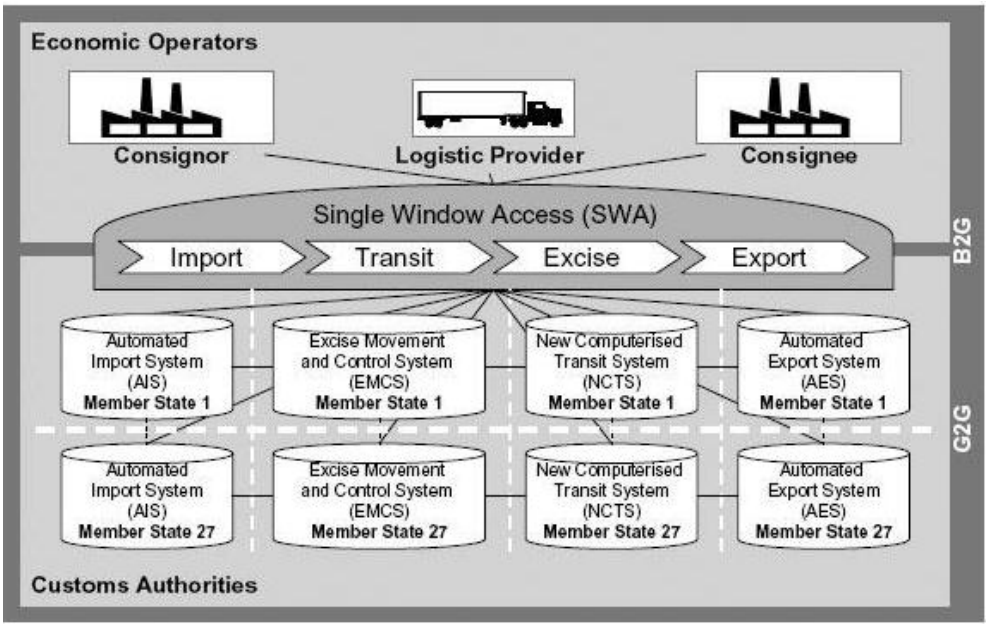
With the e-Customs EU is trying to create and enable faster and more efficient customs clearance. Granqvist, Hintsa and Mannisto define e-Customs as "*an application of IT technologies in public administration. It is connected with the organizational changes and new abilities of public services, which aim to improve quality of provided services by the government*." (Granqvist et al., 2012, p. 50).

[8] Regulation (EC) No 450/2008 of the European Parliament and of the Council of 23 April 2008 laying down the Community Customs Code (Modernised Customs Code), OJ 2008, N° L145, p. 7.

E-Customs will replace paper-based customs procedures with European-wide electronic operations, thus creating a more efficient and modern customs environment. The objectives of the e-Customs initiative are to facilitate a trade and enhance security at the EU's external borders.

The European Union (European Commission, 2012) published the "Multi-Annual Strategic Plan" (MASP) which represents the EU's program for the creation of a simple and paperless environment for customs and trade. The MASP's central part is the Single Window Access (SWA) concept (Figure 1.). This means that all traders will have access to a single electronic point for import, transit, excise and export transactions, irrespective of the member state in which their transaction starts or ends. The Single Window Access concept ensures a "single point of access" to existing and future computerized customs systems of the EU member states. This will be achieved by the integration of existing EU member states customs procedures and systems, such as the NCTS and future systems such as the Automated Export System (AES), the Automated Import System (AIS) and the Excise Movement and Control System (EMCS) with the ERP systems of the economic operators (Vogel, 2008).

Figure 1. Single Window Access concept




Source: (Vogel, 2008, p. 3)

As main advantages of the e-Customs Horvat (2011) stated time and cost savings. Other researchers (Holloway, 2007; Raus et al., 2009; Raus and Boutellier, 2010) noted additional advantages of the e-Customs implementation and use:

- The service is available 24/7 – it is not dependent on a customs working hours
- Faster custom clearance since there is no need for long procedures needed for paper documentation Lower costs because there is no need for an additional

material during the customs procedure and that there is less need for keeping shipment i.e. less warehousing costs;
- The transparency of clearly described procedures and rules of doing business supported by automatic processing IT solutions have to be uniform and accessible and equally applied to all concerned;
- The customs location and the location of the merchandise do not have to be identical.

However, the electronic data transfer requires a high degree of reliability, a stable computer system, a sufficient credit rating and an appropriate know-how regarding the compliance with the customs regulations on the part of the authorized economic operators.

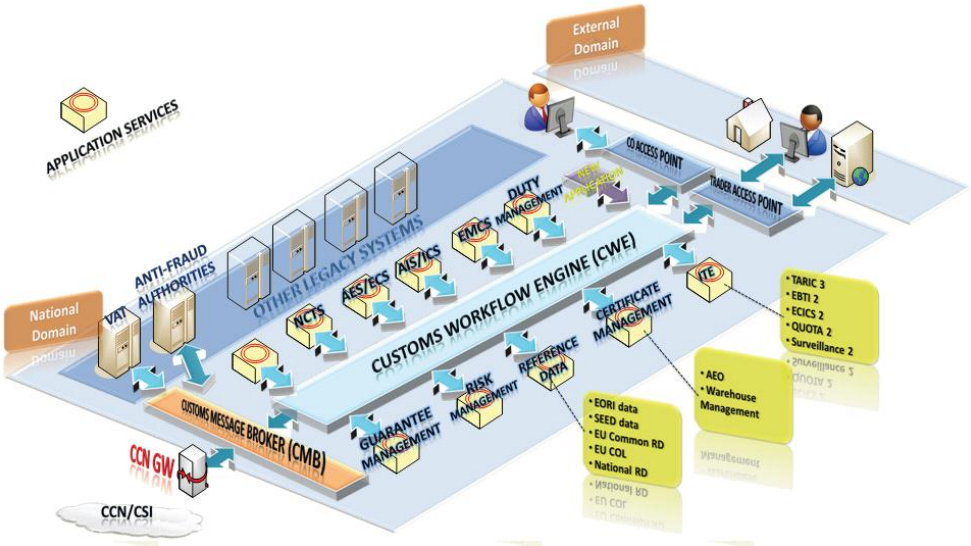
### 2.1. How does e-Customs work?

According to Holloway (2007) the potential impact of moving from paper-based procedures through the basic automation to integrated e-Customs showed huge benefits in terms of improvements in efficiency and with respect to cost savings for business and government. In addition to the actual customs clearance (import, export, transit and customs warehouse), the core of the electronic customs clearance is an automatic risk analysis module. Among others, Long (2013) states that implementation of the e-customs increases automation, especially in the reception and inspection of the customs declaration by using of red, yellow and green channels:

- Red channel - "STOP" - the goods must be inspected by the customs authority at the location of the merchandise or the forwarding agent. Until the final clarification, the merchandise remains under a customs supervision. After a positive examination, the economic operator receives the appropriate customs receipts or documents in electronic form.
- Yellow channel - "DOCUMENTATION" - with regard to the yellow channel, if enterprises submit and produce dossiers and documents according to the regulations, they can export and import goods.
- Green channel - "RELEASE OF GOODS", which will be effective within ten minutes. The shipments may then be conveniently transported to their destination.

On the import side, the responsibility concerning all aspects of a foreign trade and the customs law is shifted to the companies. Improperly declared merchandise or the lack of permissions and licenses may result in legal sanctions and a withdrawal of the permission to act as an authorized economic operator. The special software is needed to process customs declarations as a part of the e-Customs. Although the investment costs for the software and training is substantial, it is lower than the total cost of the individual and/or collective merchandise declarations.

Figure 2. Projection of an e-Customs implementation for a typical EU member state




Source: IBM (2008, 4)

### 2.2. The New Computerized Transit System

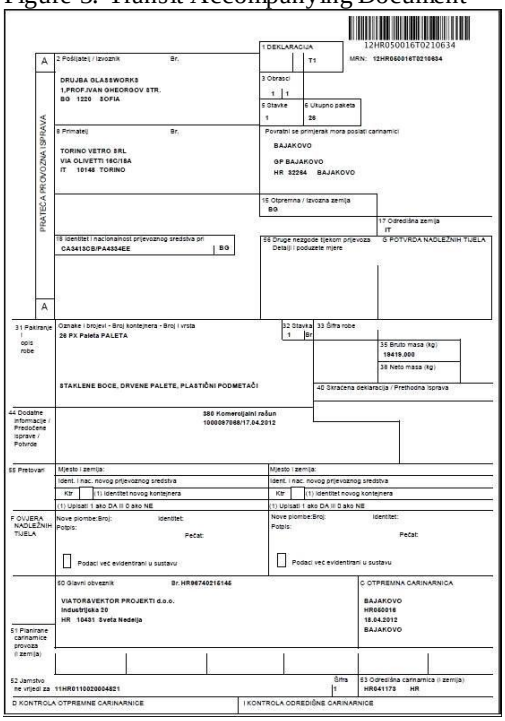
The NCTS is an electronic system of the paper-based Community Transit regime which enables a transit system for shipment from starting to delivery point no matter if the starting or delivery point are one of the EU member states or one of the countries which signed the Common transit system convention. The European Union (2001) and The Croatian Customs administration (2010) stated that main goals of NCTS implementation are as follows:

- The increase of the efficiency and effectiveness in a transit procedure;
- The improvement of prevention and fraud detection;
- The acceleration and security of carried transactions in a transit procedure.

The NCTS's main task is a control of goods movements within the EU that are not in free circulation (import duties and taxes not paid). With the usage of modern IT systems and electronic data interchange, the NCTS should deliver a more efficient system management than the current one which is based on a paper procedures.

The NCTS includes an exchange of information in the customs declaration for the transit procedure and certain activities in relation to customs officials and entrepreneurs in standardized electronic messages. It also includes the implementation of transit procedures in shipping, delivery and transit customs office and a management of guarantees for transit operations, search procedures and collection of customs duty, when the transit procedure is not completed in a prescribed manner. Additionally, Tomašević (2011) noted that NCTS includes sending and accepting of all electronic messages that are needed to start and conclude a transit procedure and, most importantly, to have the procedure done without any paper documents. Only paper document is The Transit Accompanying Document (TAD) which represents a "picture" of an electronic message in the transit procedure and printed customs declaration of transit and Movement Reference Number (MRN). (Figure 3.)

Figure 3. Transit Accompanying Document




Source: Carinska uprava RH, 2013

## 3. THE E-CUSTOMS AND NCTS IN CROATIA

The Customs administration in Croatia offered, in 1995, a possibility of submitting customs declarations on a magnetic media in order to accelerate customs procedures (Horvat, 2011). With an introduction of The Single Customs Declaration (JCD) in 2001, the submission was allowed through the Internet. Today it is almost inconceivable that a customs declaration is submitted in any other way except through the Internet.

Currently, the Croatian customs administration is working on improvements and developments related to the preparation for Croatian EU membership. They are working on preparations for the implementation of new systems (Intrastat, Export Control System, Import Control System, and Excise Movement Control System) that will support the paperless customs procedures. Therefore it is necessary to develop an electronic communication between participants in the customs procedure - between the customs and businesses (G2B service[9]). In order to ensure a proper implementation of an electronic data interchange and the fundamental principles of governing the electronic exchange data and service of electronic business, the Customs administration adopted The Rules for electronic data exchange system (e-Customs). This rules define obligations of electronic data exchange users and Customs administration as a service delivery operator.

[9]G2B – short for Government-to-Business - include the operations of government and companies. It is a non-commercial interaction between government and business sector. According to (Horvat, 2011, p. 33)

Babić (2012) stated that NCTS is the first system of an electronic business in the Customs Administration, which was applied on a national basis in Croatia. The implementation of NCTS in Croatia started on July 1, 2011. Entrepreneurs communicate with the NCTS system and exchange the information about the specific transit procedure which enables timely information about the procedure progress. The implementation of NCTS allows the Croatian customs administration an information exchange of all transit procedures with other European customs administration and continuous movement of shipments from the starting point to the final destination (Carinska uprava RH, 2013).

## 4. THE E-CUSTOMS AND NCTS INFLUENCE ON COST SAVINGS AND TRANSIT TIME

Several researchers (Gordhan, 2007; Gwardzińska, 2007; Widowsson, 2007; Horvat 2011; Tomašić 2011; Babić 2012) stated that the implementation of NCTS and e-Customs have many advantages for all stakeholders in a transit procedure (transporters, forwarders, authorized importers, authorized exporters and other entrepreneurs) as well as for the government. The main advantages are: faster flow of goods, more efficient transit procedure, paperless customs clearance and shorter queues of trucks at border crossings, lower costs of a customs procedure.

Doyle and Janssens (2011) found that the implementation of NCTS brought financial benefits to both public and private users by increasing their productivity. Although there has not been real cost-benefit analysis of the NCTS, their research of the NCTS in EU showed that it has obtained a productivity gain of about 30 minutes per shipment. Based on average labor gross costs of EUR 30,00 per hour and 8.800.000 movements in 2008, the use of NCTS would achieve an annual cost saving of EUR 132.000.000. The research also showed a potential transit time savings totaling at 3000 working days. Although the labor cost may be smaller in some areas of the EU, this research shows impressive cost savings. In Vietnam, enterprises which have participated in the e-customs during the pilot period said that in terms of the green channel, enterprises received a feedback in only three minutes. This has created savings in time needed for the customs clearance (Long, 2013).

In Croatia there has been around 1,1 million MRN since the implementation of the NCTS. (Table 1.)

Table 1. Number of Movement Reference Number in Croatia

| Year | Number of MRN |
|---|---|
| 2011 (from July 1, 2011) | 250.000 |
| 2012 | 630.000 |
| 2013 (until May 1, 2013) | 220.000 |
| Total | 1.100.000 |

Source: Carinska uprava RH, 2013

According to the Croatian bureau of statistics (2013), an average salary in Croatia during 2011, was 5.441 HRK. During 2012, it was 5.464 HRK, and in March 2013, it was 5.516 HRK. Based on a data from the Croatian Customs administration, an average savings per MRN and a data from the Croatian bureau of statistics, it is possible to calculate the savings in a transit time and costs that come with the NCTS implementation in Croatia. (Table 2.)

Table 2. Savings in HRK in Croatia after NCTS implementation

| Year | Number of MRN* | Total time savings (hours)** | Price of hour (HRK) | Total savings (HRK)*** |
|---|---|---|---|---|
| 2011 (from July 1, 2011) | 250.000 | 62.500 | 32,38 | 2.023.750,00 |
| 2012 | 630.000 | 115.000 | 32,52 | 5.181.900,00 |
| 2013 (until May 1, 2013) | 220.000 | 55.000 | 32,83 | 1.805.650,00 |
| Total | **1.100.000** | | | **9.011.300,00** |

Source: atuhors' calculation

* based on information from Croatian Customs administration

** average 15 minutes per MRN – based on information from Croatian Customs administration

*** based on 168 working hours per month

The previous table shows a total savings of 9.011.300,00 HRK from July 1, 2011 until May 31, 2013, after the implementation of NCTS. Besides, there are time savings due to the faster creation of a customs declaration (an average of 15 min per shipment). This can result in a shorter transit time and an earlier release of truck (or any other form of transport) for the next upload and by that, a better vehicle utilization. There is also an additional saving in the logistic costs because there is no need for issuing of a paper documentation on the country border which creates a savings of an average 250 HRK per procedure. This savings only increase benefits of the NCTS implementation for entrepreneurs especially those who have several procedures per day.

## 5. CONCLUSION

In a today's world, the customs administration has to be ready to quickly adapt to the needs of a trade and continue to follow the constant changes in managing and controlling the business environment. Among others, the European Union member countries are pressured towards the e-Customs initiative. On a national level, the pressure comes from the need for the efficiency and cost savings as well as an information exchange and interoperability between the national administrations. On the international level, there are directives from the European commission and the need for an interoperability and a communication on the European level. This pressure is pushing countries to create e-Customs tools, one of which is the NCTS. This tools will offer a flexibility, interoperability and what is most important, a savings in cost and time for all stakeholders included in a transit procedure.

The NCTS implementation positively effects on a reduction of the number and a duration of customs procedures, on a movement of goods, a better vehicles utilization and finally, on transporters, authorized importers and exporters. The paperless procedures as one of the NCTS implementation results means a reduction in operating costs for all the stakeholders involved.

Croatia has implemented the NCTS on July 1, 2011. Besides advantages such as more efficient transit procedure, a paperless customs clearance and shorter queues of trucks at border crossings, there are financial benefits of the NCTS implementation for private and public users. Although there has not been real cost-benefit analysis of the NCTS in Croatia, a short research in this paper shows the possible financial benefits for the entrepreneurs which are result of the NCTS.

Since Croatia entered EU on July 1, 2013 further research of NCTS influence on transport costs and time should be done in order to evaluate influence of the NCTS in new environment. New e-Customs tools will be available from the July 1, 2013 which will help Customs and entrepreneurs in conducting logistic and customs procedures. This new e-Customs tools should be also researched in order to evaluate their influence on cost and time of all activities included in logistic procedures.

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# THE DISPLAY PALLET SERVING THE PURPOSE OF OPTIMIZATION OF MERCHANDIZE SECONDARY DISTRIBUTION AND MERCHANDIZE MANIPULATION

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***Abstract***

During merchandize management and distribution, especially the secondary one, practical experiences indicated certain limitations and obstacles in the use of Euro pallets. Therefore, the use of a smaller, more functional and more cost-effective bearing base marked a turning point in modern logistics. Reduced in size but with retained identity features of Euro pallets, Display pallets optimize secondary merchandize distribution, merchandize manipulation and retail merchandize display in terms of mastering time and space at lowest costs.

This paper, among other things, attempts to answer the following question: what are the advantages and benefits of using Display pallets for coordination of material, products and merchandize movement in organizational and physical terms? The starting point is the review of the functionality of the present transportation and storage unit, as well as loading, manipulable and sales unit – the Euro pallet. The aim of the review is to indicate more efficient solutions in merchandize secondary distribution and retail merchandize display. Namely, due to its dimensions, the Display pallet enables pallet merchandize transport to the exact sales point in retail chains, contributing to saving time and reducing employees' work. Besides facilitating merchandize manipulation inside stores and warehouses, the advantage of the Display pallet use is the pallet's applicability in direct merchandize display in retail chains. Ultimately, merchandize is always available to consumers, which is the most important element that affects merchandize sale.

**Keywords**: Display pallet, secondary distribution, manipulation, pallet merchandize display.

## 1. INTRODUCTION

Viewed as an activity, modern logistics is a part of the process of supply chain which plans, implements and controls effective and efficient forward and reverse flow, merchandize and services storage, as well as related information storage, between the point

of origin and the point of consumption in order to fulfill consumer demands (Milovanović et al., 2009, p. 3). Established as a science, logistics is, according to Zelenika, a set of interdisciplinary and multidisciplinary skills which study and apply regularities of numerous activities functionally implementing all partial processes in mastering space and time transformations of material, products (…) into safe, rapid and rational unique logistic processes from the delivery point to the receipt point. The aim of the previously said is to minimally invest potential and resources and maximally meet market demands (Zelenika & Pupavac, 2008, p. 18).

Increase in quality level of business logistic performances through the implementation of the new information technology for the purpose of improving the development of merchandize flow capacities and protocols presents new, evolutionary dimensions of logistics. In order to meet the growing consumer demands while maintaining business profitability, logistics has lately been faced with radical changes in its functions. The new, evolved term "logistics" encompasses not only activities related to physical movement of merchandize, both in the upstream segment (supply) and downstream segment (sales), but also customer and supplier relationship management (Milovanović et al., 2011, p. 341).

In accordance with the revised focus of logistics, one of the most significant turning points of logistic philosophy relates to a more adequate merchandize manipulation along with cost reduction, time saving and minimization of the majority of certain obstacles in the present bearing bases use in merchandize secondary distribution and manipulation. By reducing the size of the present and widely accepted Euro pallet, with a few functional moves, and by increasing building materials spectrum, the Display pallet becomes a representative working tool, significantly cost-effective in production and distribution systems.

Along with the introduction and the conclusion, this paper contains two analytical chapters. The first chapter discusses the functionality of the present loading, transportation, storage as well as manipulation unit − Euro pallet. This chapter also provides a brief analysis of presently applied system of merchandize distribution and manipulation and indicates more cost-effective solutions related to implementation of the pooling system (pallet rental). The second chapter emphasizes the advantages of the newly accepted platform, the Display pallet, by the use of which the optimization of merchandize secondary distribution and manipulation is achieved. The following part of the paper focuses on presenting arguments for recorded limitations of Display pallet use in practice. Identifying and eliminating those limitations is the foundation for achieving best business effects and goals – cost reduction in merchandize manipulation and distribution, waste minimization and delivery time reduction, the purpose of all this being to achieve a more cost-effective business and to improve the availability of merchandize to consumers.

## 2. MERCHANDIZE DISTRIBUTION AND MANIPULATION USING EURO PALLET

In order to ensure the smooth functioning of business activities, supply chain participants (wholesalers and retailers, manufacturers, vendors, suppliers, etc.) implement logistic solutions. Their calculated choice attempts to reduce costs, reduce the time needed to fill an order, and minimize stock level in order to maintain business profitability while meeting complicated consumer demands. As Pupavac says, logistic chains management presents one of the greatest challenges to modern management practitioners and theorists

(Pupavac, 2006, p. 291). In every supply chain link, the focus is always on merchandize – a product, which should be at consumers' disposal right on time, in a safe way and in controlled conditions through a well-organized distribution network.

According to Zelenika and Pupavac, distribution, in its narrow sense, is viewed as a set of planned, coordinated, regulated and controlled unmaterial activities (i.e. functions, processes, measures, tasks, operations, activities…) which functionally and efficiently connect all partial processes in mastering space and time transformation of finished products from manufacturer to costumer or end user, i.e. consumer (Zelenika & Pupavac, 2008, p. 33). When viewed comprehensively and interdisciplinary and/or multidisciplinary, distribution covers the overall flow of materials and related flows of information on the input, passage and the output of a single system (Zelenika & Pupavac, 2001, p. 359). Here, the physical distribution relates to the physical flows of raw materials, materials and products. Thus understood, distribution sometimes becomes synonymous with business logistics in general.

Merchandize usually passes through two stages of distribution. The first stage, the primary distribution, implies the incoming flow of merchandize into the distribution centre, warehouse or manufacturing facility where the value is added to the product. Merchandize distribution from a warehouse or distribution centre to the end user is known as the secondary distribution. In highly developed countries, total costs of physical distribution are assumed to amount to around 8% of the income generated by sale. When analyzing the total costs of physical distribution, it can be seen that transportation costs amount to 37%, costs of holding stock amount to 22%, warehousing costs amount to 21%, and distribution administrative costs amount to 20%. In transition countries, on the other hand, the total costs of physical distribution amount to around 25% of total income generated by sale (Zelenika, 2005, p. 48). When compared to the physical distribution costs in highly developed countries of the world, the costs of physical distribution in transition countries are very high and, as such, very unfavorable to the participants in the process of physical distribution, which requires optimization of this area.

However, the efficient product manipulation depends not only on the mode of transport (and storage), or on the distribution of the product, but also on the method of managing the packaging – a bearing base on which the product reaches the end users.

### 2.1. Role of pallets in merchandize secondary distribution and manipulation

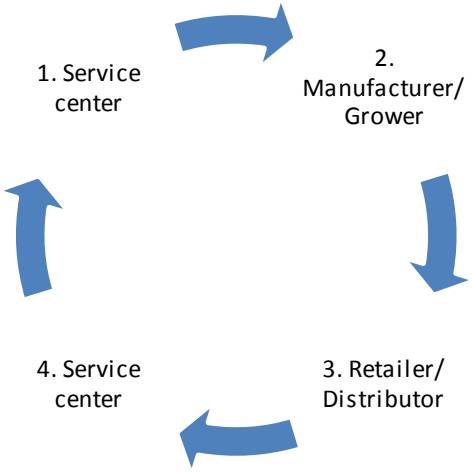
Pursuant to the realization of numerous aspects of implementing logistic solutions that give certain weight to logistic systems, merchandize distribution and manipulation has lately become hard to imagine without using bearing units − pallets. The present merchandize distribution and manipulation was centered around pallet traffic based on the principle of delivering the merchandize to the recipient, when upon delivery of the products the receipt of empty pallets would follow. This way of running a business proved quite non-cost-effective for the company. Despite stiffness, durability and stability of a pallet, due to its possible inappropriate handling, the pallet is not returned in the same condition as when sent to the market and ultimately it becomes useless. What is more, such a pallet brings about unnecessary business losses.

An alternative and much more efficient solution has been developed by the CHEP Company, the world leader in pallets and containers business. Due to the modern technology and the base of more than 285 million pallets as well as doing business in 56 countries worldwide (*CHEP Home page*), CHEP offers excellent, environmentally friendly

logistic solutions that ensure the optimum platform for the protection of end consumers' merchandize. CHEP offers cooperation in pallet rental (pooling), merchandize loading and informing about shipment destination to production and retail businesses. The pallets are rented, shipped to the manufacturer or the importer of the merchandize and collected from the unloading point after being used in storage and transport. This is followed by a detailed inspection and repair of pallets in service centers.

Pallets circulation from service centers, through clients to the end users can be seen in Figure 1.

Figure 1 Pallet pooling system




Source: Adjusted according to: "Equipment Pooling Systems from CHEP", *CHEP Home page*.

Service center rents and delivers pallets to manufacturers and/or growers in order to distribute and manipulate their merchandize within the supply chain. Upon receiving pallets, manufacturers and growers load their merchandize and ship the merchandize to unloading point through the supply chain. There is a retailer or a distributor at the end of the supply chain who unloads merchandize whereby empty pallets are returned to the nearest service centre. The service centre inspects and repairs all returned pallets to ensure they meet specified quality standards. The pallets are then made ready for re-use.

The main benefit of the pallet pooling system is the ability to reduce fixed costs of procuring and maintaining equipment, leaving the management of pallets to an outside business. As manufacturers are not obliged to purchase a bearing base for merchandize distribution and manipulation, instead of investing in the purchase of work equipment of this type, they can focus on their primary activity. Pallet pooling also generates following benefits for manufacturers:

- eliminate the need for engaging their own business in collecting empty pallets,
- reduction of the business administrative burden,
- eliminate pallet inspection and repair costs,
- reduced possibility of pallet loss,
- more efficient and more cost-effective merchandize manipulation (greater transferability with less handling and lower costs) on standardized platforms,

- innovation benefits in bearing bases field are generated without manufacturers' own capital investment.

Pallet pooling system is an equally adoptable solution for businesses with a local and a simple distribution system as well as for businesses engaged in complex, international distributive networks. As a result of simple logistic principles and positive effects brought about by implementation of such solutions in business running, pallet pooling proves to be an ideal solution for merchandize secondary distribution and manipulation.

The system of renting reusable pallets is a widespread phenomenon in Western Europe. The system's popularity is growing in Central and East Europe with the system being used by businesses in search for solutions for reducing supply chain costs.

Regardless of the business location and the specificities of the internal business operations, a pallet as the basic platform for merchandize manipulation presents the business imperative from the perspective of logistic structure.

### 2.2. Characteristics and application of Euro pallet

One of the most widely accepted bearing bases for merchandize storage and transport is a wooden, so called Euro pallet or EPAL pallet, named by licensed manufacturer *European Pallet Association* (*EPAL Home page*). Labeled with an EPAL quality mark, Euro pallets guarantee safety through merchandize distribution and manipulation, including merchandize transport, storage etc.

Standard Euro pallet dimensions are 1200x800x144 mm, and the whole pallet is reinforced with 78 special nails regulated by a special standard. Bottom boards of the Euro pallet must have chamfered edges and a breadth of 22-25mm. Such a pallet, usually made of duly selected quality pine or fir tree, weighs between 25 and 32 kilos. Pallets manufactured by EPAL can be seen on the market also in the following dimensions: 800x600mm (Pallet Eur 6), 1000x1200mm (Pallet Eur 3) and 1200x1000mm (Pallet Eur 2).

Stiff and practical, standard Euro pallet is designed in a way that, when staying flat on a shelf or forklift, can withstand the following loads ("Load-bearing capacity", *EPAL Home page*):

- 1000 kg (nominal load), if the load is distributed randomly on the surface of the pallet,
- 1500 kg, if the load is evenly distributed across the surface of the pallet,
- 2000 kg, if the load is compact and evenly distributed across the whole surface of the pallet.

When stacked, the lower pallet must withstand an additional load of 4 000 kg, if it is resting on a flat, horizontal and rigid surface and if the load is exerted horizontally and across the whole surface of the pallet.

Due to their robust construction, Euro pallets ensure durability and stiffness for safe handling of heavy loads; they increase the load stability and minimize the merchandize damage during its manipulation. They are adaptable for automated production and storage facilities where they increase work efficiency. Since they are made of high quality materials, Euro pallets reduce the risk of injuries and allow safe handling. Due to the characteristics mentioned, Euro pallets are among top choices for packing merchandize for delivery throughout Europe.

Despite the widespread use of Euro pallets, there is no global standardized pallet. The pallet world is basically divided into three parts:

- the general size in North America is 48x40 inches,
- in Asia it is 1000x1200 mm, 1100x1100 and also 800x1200 mm,
- in Europe 800x1200 as well as 1000x1200 mm.

Table 1 Comparison of characteristics of the most commonly used pallets

| PALLET | EUR-PALLET | INDUSTRIAL PALLET | ASIA PALLET |
|---|---|---|---|
| **DIMENSION** | 800x1200mm | 1000x1200mm | 1100x1100mm |
| **LOAD-BEARING CAPACITY** | 1500kg | 1500kg | 1300kg |
| **EXTRA LOAD** | 6000kg | 6000kg | 5200kg |
| **DEAD LOAD** | 25kg | 30kg | 30kg |
| **APPLICATION** | Exchange pallet | Exchange pallet | Export |

Source: "Pallet comparison", *EPAL Home page.*

Despite the different dimensions, load capacity of the marked pallets is approximate, with the Asia pallet standing out from the other pallets with its somewhat lower load-bearing capacity (1300 kg) and its reduced extra load (5200 kg). Euro pallet with dead load is the lightest compared to other pallets and weighs 25 kg. Only the pallet used in Asia is basically intended for export, while the other two are used in merchandize manipulation through the pallet exchange network.

Favored due to its characteristics, especially to its high load-bearing capacity, its stiffness, as well as security and stability of the load it carries, the Euro pallet cannot be applied in all business aspects. Its dimensions, often pointed out as an advantage, become deficiencies of this load-bearing unit in certain cases. This is especially seen in retail merchandize display. When viewing various commercial areas with their much different surfaces, measures and dimensions, difficult and sometimes impossible merchandize manipulation is evident, which requires optimization of logistic solutions.

## 3. DISPLAY PALLET – TURNING POINT OF MODERN LOGISTICS

Due to the increasing importance of logistics in today's economy, and since, according to Šošić, logistics represents an area in which it is possible to significantly reduce operating costs and thus increase business efficiency and competitiveness in global market competition (Šošić, 2010, p. 105), it is necessary to point out the areas of potential logistic network optimization. In addition to the cost of materials, supply and production, subject to optimization in the logistic network can be the sphere of load storage, distribution, manipulation, etc. A new bearing base, fully customized to work has the key role in this segment – the Display pallet, which, in terms of its specifications, is much more efficient and cost-effective than other units for merchandize manipulation and distribution.

### 3.1. Display pallet advantages and its application in the supply chain

The Display pallet is an environmentally sustainable, reusable packaging that appears in dimensions ½ Euro pallet (800x600mm) or ¼ Euro pallet (600x400mm). These dimensions are what makes the Display pallet a very important logistics innovation. Due to

its format which sets the Display pallet apart from the competing bearing bases, the pallet is very suitable for merchandize distribution and manipulation and direct merchandize Display in retail chains, with an easier implementation of FIFO requirements.

Depending on the purpose and nature of manipulated merchandize, the Display pallet can be made from various materials and their combinations. A pallet sized 800x600 mm is made of duly selected quality wood and it is angularly reinforced with galvanized steel and plasticized central posts. Steel block with a high load-bearing capacity ensures durability during merchandize handling and transportation and guarantees its safe manipulation. The average weight of a Display pallet sized 800x600 mm is 13 kg, the maximum bearing capacity for safe load handling being 500 kg. When stacking loaded pallets on a solid surface, it is recommended that the load should not exceed 2000 kg.

An advertising Display pallet sized 600x400 mm has the average weight of 2.2 kg and is made of polypropylene, a material that does not pollute the environment, eliminates splinters and nails, does not absorb moisture and is easy to clean. It is extremely durable, thus reducing product and packaging damages. The recommended maximum load-bearing capacity is 300 kg, which enables safe working load manipulation. When stacking pallets, load exceeding 800 kg is not recommended.

In terms of logistics, a great step forward creating benefits for all participants in the supply chain has been made by functional reduction of Euro pallet dimensions. Benefits are generated in merchandize production as well as in its transportation, storage, distribution and Display. Cost aspect is not to be neglected, since the Display pallet is cheaper and more cost-effective in comparison to any other competitive bearing base.

From the perspective of retail chains, the use of Display pallets proved to be an excellent solution. In addition to enabling easier merchandize manipulation, an advertising Display pallet is an excellent base for direct display of merchandize having a large sales volume (e.g. water, UHT milk, soft drinks, flour, sugar, etc.). The Display pallet increases visibility, easier recognition and accessibility of systematically displayed products while contributing to the aesthetic impression of the commercial facility. It saves commercial space and reduces the time and cost of preparation (and removal) for products promotion, which affects the sales growth. Ultimately, quicker and easier display of merchandize reduces the work within the commercial facility, which contributes to business productivity and efficiency.

The use of Display pallets, therefore, generates several key benefits: it increases productivity, reduces disruption of customers, increases sale and reduces damage and breakage of the carried products.

Table 2 Benefits of merchandize manipulation using the Display pallet

| DISPLAY PALLET BENEFITS | MANIPULATION EFFECT |
|---|---|
| Productivity increase | Merchandize Display cost reduction |
| Reducing customers' disruption | Silent and elegant solution |
| Sales growth | Better and faster merchandize accessibility to customers |
| Damage and breakage reduction | Less manual manipulation, less merchandize damage |

Source: author's creation

By accepting the Display pallet as an innovative logistic solution, the benefits of the pallet's use have been experienced by all of the businesses:

- whose products are displayed directly in retail chains (more adequate merchandize display, better merchandize access, brand control),
- using any disposable pallets (lower pallet cost),
- engaged in business actions with retail chains,
- having problems with pallet loss or damage.

### 3.2. Merchandize secondary distribution and manipulation using Display pallets

Although the advantages of Display pallets are recognized and accepted in theory, these platforms are still not fully implemented in practice. Most participants in the supply chain keep on using Euro pallets as basic units for merchandize distribution and manipulation. The usual practice is reasonable and justified in primary merchandize distribution by trucks and trailers to the central points of loading/unloading, during which the merchandize is commonly distributed by separate orders. In such cases, merchandize is delivered to one customer (up to three customers) with the time needed for searching, finding and unloading merchandize for a specific customer being minimized. Contrary to the primary distribution, the secondary, capillary distribution implies a collective picking of products intended for a number of commercial facilities – a number of customers, during which the use of smaller, more cost-effective bases − Display pallets, presents a much more practical solution. Namely, in the situation of collective merchandize picking for secondary distribution and for a number of different customers, the use of standard Euro pallet proved to be very non-cost-effective. Unloading specific merchandize for a specific customer becomes more difficult due to searching, 'ransacking' the Euro pallets, which results in a time loss. In such circumstances, merchandize delivery cost increases, as this requires searching for, finding and separating merchandize for a costumer.

To avoid searching collectively picked Euro pallets, to save time, and to reduce merchandize delivery cost, Display pallets are gradually being implemented in practice. Their format makes them more applicative for merchandize distribution by individual, separate orders. Display pallet size increases product visibility and accessibility as well as product recognition. It is estimated that up to 90% of customers are supplied using such a method of separation of merchandize in trucks, thus reducing the time needed for merchandize finding and unloading.

Although proven as an adequate means for optimization of merchandize secondary distribution, this logistic solution requires adducing functional grounds which will justify Display pallet reputation as a revolutionary innovation in the field of logistics. Specifically, regardless of the delivery of merchandize picked by individual orders and despite systematic and more functional stacking of merchandize using Display pallets, considerable physical engagement of distributors is required for unloading. In most cases searching and unloading pallets are still done manually in secondary distribution, since most retailers − customers have no pallet stacker. The result of this practice is a lower merchandize delivery cost (because this is a distribution based on individual orders, which in theory does not require 'ransacking' pallets in search for products), but also a great and demanding physical engagement of distributors. In addition, the Display pallet proved to be a very unstable platform if standing on its own even on a flat surface. Even in the case of compliance with the maximum load-bearing capacity to ensure safe load manipulation, there is a possibility

of a pallet collapse, if the pallet is not paired with another bearing base. This presents a serious problem in the distribution of merchandize, if the vehicle space for distribution is not completely filled with pallets.

Typically, slower modes of transport, lower transport costs as well as longer delivery periods mean higher costs of holding stocks (Vouk, 2005, p. 1021). Namely, despite faster and easier Display pallets filling in comparison to filling their competitive bearing bases, merchandize manipulation using Display pallets has another aggravating segment. Their commonly emphasized suitability for production and storage facilities increasing work efficiency becomes questioned in practice. Designed for faster, simpler and more cost-effective merchandize manipulation by individual orders on site, Display pallets used in warehousing spaces showed certain limitations. Compared to collective merchandize picking, filling pallets by separate orders slows down storage processes and implies more work in merchandize stacking, which increases storage costs. According to Bloomberg, average storage costs amount to around 10% or more of the total integrated logistics cost for most businesses (Bloomberg et al., 2006, p. 172).

Suitable for secondary distribution of merchandize to small costumers, the Display pallet has not been applied in large customers' businesses yet. Large shopping centers have still not recognized the benefits of Display pallets use and do not provide the option to receive and return Display pallets. The standard Euro pallet is still the basic bearing base for merchandize manipulation with all its limiting factors in terms of searching for, recognizing and unloading collectively picked merchandize.

Compared to their competitive bearing bases, Display pallets showed greater adaptability in the logistic network. Doing business with Display pallets pointed out the benefits of their use, the ultimate goal being to ensure optimization of merchandize secondary distribution and manipulation. At the same time, the above mentioned limitations justify the conclusion that it is necessary to thoroughly review the efficiency and applicability of Display pallets, especially in storage facilities. Since the Display pallet represents a novelty in the world of logistics, it can be expected that the pallet will gradually adapt to the business for which it was intended. Only thus will the Display pallet justify the reputation as revolutionary logistic solution for optimization of merchandize secondary distribution and manipulation.

## 4. CONCLUSION

The present practice of merchandize distribution and manipulation was based on the use of robust Euro pallets which, despite their durability and stiffness and guaranteeing safe load handling, are not applicable in all aspects of the business. The mentioned is especially manifested in the retail merchandize Display and aggravated merchandize manipulation in smaller commercial facilities.

Some of the key obstacles in optimization of merchandize secondary distribution and manipulation can be overcome by using a functional and cost-effective platform – the Display pallet. Reduced in size and increased in function compared to its competing platforms, the Display pallet presents a significant step forward in the field of logistics. However, despite the convenience and better adaptability in managing logistic challenges, the use of Display pallets still faces some limitations. Among other things, the stability of the Display pallet becomes questionable if the pallet is not supported by another bearing base, which presents a serious problem if the merchandize is distributed by a vehicle with

loads below its bearing capacity. Practice shows that the use of Display pallets in storage facilities failed to meet its purpose, since this requires more storage work.

The limitations mentioned in the article can and should serve as a starting point for customizing Display pallets for their business purposes, in order to realize the set goals of logistics in practice as soon as possible.

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## IV. LOGISTICS TECHNOLOGY AND EDUCATION

# IMPLEMENTATION OF RFID TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT

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***Abstract***

The globalization of markets and new technological innovations exert influence on the development of new models and structures in supply chains. The role of integrated supply chain will strengthen in the future that will initiate a new role in functioning and development of marketing channels. The processes of globalization of markets will fully promote a numerous horizontal and vertical integrations in the supply chain management. Integration of the total supply chain of products is focused on retailers that are able to estimate accurately future sales trends. Electronic commerce business activities relate to the interaction between the various participants along the supply chain. Implementation of RFID (radio frequency identification) revolutionizes supply chain management by making it more efficient, thanks to the movement of product information between participants in the supply chain. RFID technology leads to fully reliable solutions through secure identification and monitoring of products in supply chains. These changes in supply chains come with implementation of global standards GS1 EPCglobal, which consists of a combination of radio frequency identification, using the existing communication networks and electronic product coding. Thanks to the new GS1 EPCglobal system, opportunity for identifying a unit of the product is created along the entire supply chain in marketing channels. RFID technology has completely changed the interrelationship in the supply chain management due to global standards of radio frequency identification GS1 EPCglobal.

**Keywords:** global market, supply chains, electronic commerce, RFID, GS1 EPC Global

## 1. INTRODUCTION

Macro environment is substantially altered by the complexity of the market, scientific and technological progress, legal regulations and the effects of trade policy, and influence the development of new models and the structure of supply chains. New principles become

important, which relate to the maximum market flexibility and long-term competitive advantages based on the latest scientific and technological achievements. In order to ensure competitiveness in the global market in terms of the constant influence of macro environmental factors on integration of the supply chain, it is necessary to provide answers to the following questions:

- What is the impact and importance of the global market and new technological innovations in the development of new models and the structure of the supply chain?
- How is the RFID technology revolutionizing supply chain management?
- What allows the identification of unit product along the entire supply chain in marketing channels?
- What are the key changes in the relationship between participants in supply chain management?

The above-mentioned questions point to technological innovations in supply chain management, which requires constant change of business strategy in order to maintain compliance with the macro-environment. The basis of GS1 center and its network of national GS1 associations are the development and implementation of global standards in order to improve operations in the supply chain in the global market. The cooperation with institutions for standardization, professional associations and other organizations, GS1 leads to the development and application of standards in the supply chain, with the main aim to unify business communications. Activities of GS1 Serbia are part of the Commission for the automatic identification and data capture at the Institute for Standardization of Serbia (ISS), which work on international standards ISO/IEC JTC 1/SC 31 (AIDC) and CEN/TC 225 (AIDC technologies). GS1 Serbia offers five different ranges of bar code numbers, where the articles with variable weight are assigned with bar code prefix GS1/EAN 27, and logistic units (collective packages and pallets) with GS1/EAN 128 code.

## 2. THE IMPACT OF MARKET GLOBALIZATION AND INNOVATIONS ON THE STRUCTURE OF SUPPLY CHAINS

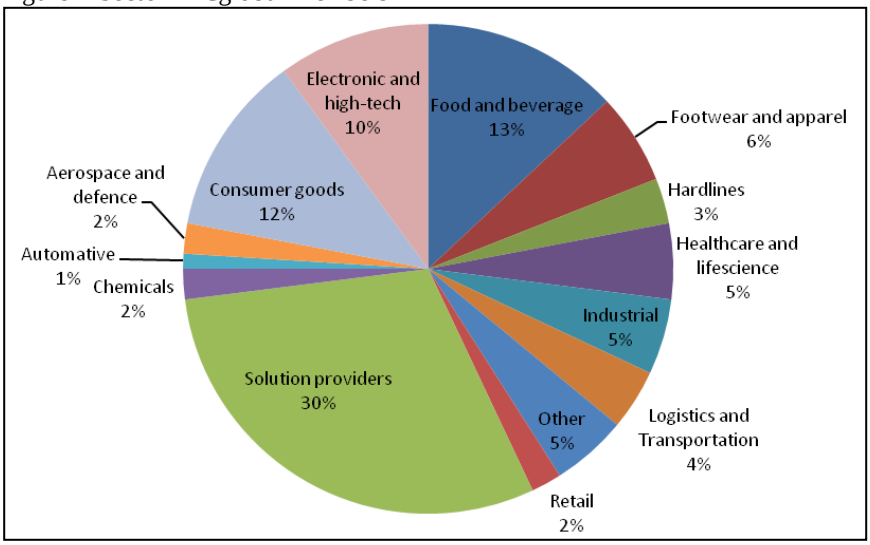
The impact of market globalization and new technological innovation lead to the development of multi-channel strategies, which as a result has a set of marketing channels, which makes products and services available to consumers in a convenient way, daily or in long term. Internet based marketing channels become main channels of many organizations. In the context of multi-channel strategy, synergy means the use of one channel for improving the efficiency and effectiveness of the other channels in the mix (Rosenbloom, 2013, p. 8). The strategy of marketing channels, especially multichannel strategy, has attracted considerable attention as a means to achieve sustainable competitive advantages in the structure of supply chains. Multi-channel strategy involves tracking the movement of products through multiple channels, integration of information and having information available for decision-making. Therefore, it is necessary to implement an identification systemthat will be compatible to all participants in the supply chain on the global market.

The global electronic market has the characteristics of a free market and free sellers (Končar, 2008, p. 183). The phenomenon of e-commerce has completely changed the traditional marketing channels and supply chains. The expansion of the market comes with electronic commerce so that the market becomes global. Considering that the potential customer can be in one country, and the seller in the other, it is essential to monitor

products adequately, first to make sure that what is offered on the website is available in stock. It is necessary that the consumer know where the product is during delivery, and at the end to be sure that the product will come on time and in adequate form to the consumer. In order to follow this complex system of supply chain on the global level, it is necessary to have a consistent system for identifying products that will be supported throughout the structure of the supply chain.

The structure of supply chain on the global market implies the strong long-term relationship between the participants. The question is which participant is the holder of the implementation of new technological innovations in identifying items in the supply chain. The position of some participants in marketing channels means strengthening in contemporary conditions. Manufacturers with a strong manufacturing brand implement technological innovations in production and in the exchange of information with their partners in the supply chain. The goal is rapid exchange of information in order to deliver a product to the right consumer, in the place and at the right time. On the other hand, strong retailers invest in product identification in order to manage inventory and ensure adequate quality of the products in stores. In order to have an efficient supply chain, retailers monitor and identify products in collaboration with their suppliers, which have the character of permanent supplier. The focus is on the consumer with tendency to respond adequately to consumer's needs, to respond quickly to demand, altogether with the rationalization of processes and lower costs.

Figure 1 Sector EPCglobal members




Source: Thiesse et al., 2011, p. 330

Networking supply chain is established with the aim of rationalizing the process, the unique identification, effective exchange of information, an adequate response to consumer demand, etc. If we observe the activities of the participants who are members of EPCglobal, we can see that the majority of companies are in the sectors relating to final consumption. Retailers occupy only 2%, which is mostly caused with process of concentration in retailing that resulted with small number of huge retailers. Sectors such as consumer goods, food and

beverage, and footwear and apparel are also participants connected with retail sector. Retailers who are EPCglobal members and the initiators of identification systems application are the largest trading company in the world that work globally, such as Wal-Mart, Carrefour, Tesco and Metro and they have a significant share in the total retail income.

## 3. CHARACTERISTICS OF IMPLEMENTATION OF THE RFID TECHNOLOGY

RFID technology is a relatively new technology of radio frequency identification, which allows tracking of products and their identification using radio waves. Incorporating RFID tags or labels enables the transfer of information using radio waves to electronic readers, thus creating the conditions for products with embedded chips to be scanned remotely. There are many applications for RFID technology, but in the context of marketing channel management, core applications relate to inventory tracking, supply chain management and increasing the efficiency of the buying process in retail (Rosenbloom, 2013, p. 93). RFID technology is truly revolutionizing not only the control of inventory in supply channels, but also the complete purchasing process in retailing.

Radio waves are used as the basic medium, and the entire technology is based on microchip antenna, electronic product code and the wireless computer. Electronic Product Code (EPC) includes a variant of RFID technology resulted from the UPC. Basically, there are active and passive labels (Rosenbloom, 2013, p. 510). Passive RFID labels include small microchips where the encoded information is read when the chips are scanned from pallets, boxes or individual product. The reader converts the code into identifiable information (ex. where the product is, where it is being directed, and so on.). In contrast to the passive ones, active RFID labels require a power source and they are larger, more expensive and have much longer range than passive. In an active system, the battery in the RFID tag indicates the effective range of geographic labels and supports other features that are not possible with passive labels, such as sensitivity to temperature changes in the environment (Rosenbloom, 2013, p. 412). Data from the RFID tags come to the main computer through communication interfaces, which is almost identical as the bar code label, and sends data to computer systems for interpretation, storage and the overall activities relating to it.

RFID technology has been adopted by many major retailers (Metro, Tesco and Wal-Mart), because it allows the elimination of the lack in monitoring the stock, reduces control and comes to the integration of the supply chain. Intensive globalization in retailing requires improvement in supply chain efficiency. In the retail supply chains, four areas have the major priority: inventory management, storage management, demand planning and transport management. The advantages of RFID in automated data collection relate to elimination of the labor force in monitoring the inventory in retail. Thanks to RFID, technology retailers create conditions for improved collaborative planning, forecasting and inventory management with benefits and cost savings. That means a reduction in labor costs, and also administrative costs, while IT benefits are manifested in easier monitoring and making reports (Thiesse et al., 2011, p. 333). In that way, the value of information grows, information can be easily collected and stored, in order to respond adequately to rapid changes in demand and make quick business decisions.

RFID is considered as technology that intensifies cooperation and coordination of the participants in the supply chain due to better visibility of the physical processes in the supply chain. Research, implementation, testing and funding of innovative technologies such as RFID is linked to the large retail companies that have the financial resources for technology development. Retail companies have a difficult task to convince their suppliers and intermediaries, as well as companies from other industries about the benefits of RFID technology and the feasibility of investing in its implementation. RFID technology is the most important technology for the Metro Group (Metro Group, 2013). With it, the data is retrieved and transmitted on a chip that is built-in thin labels, which are on logistic units such as pallets. This chip saves the product number, which contains a bar code and serial number. In this way, each object equipped with this chip, is contained in the database, has its own "identity" and cannot be replaced by any other. The code is read wirelessly using radio frequency identification devices, and then this information is regulated by special software, which stores it in the database. The shipment of a product from the manufacturer to market can be followed in the database. Thus, all participants in the supply chain, manufacturers, suppliers and retailers, know where the goods are located at any time.

## 4. GS1 EPCGLOBAL STANDARD IN SUPPLY CHAIN

Identification of products through GS1 standards is much more than identifying and scanning products, thanks to global standards, thus creating the possibility of establishing a global market. The GS1 company prefix assigned to company allows each company to create any GS1 identification key such as GTIN (Global Trade Item Number), GLN (Global Location Number), SSCC (Serial Shipping Container Code), GRAI (Global Returnable Asset Identifier), GIAI (Global Individual Asset Identifier), GSRN (Global Service Relation Number) and GDTI (Global Document Type Identifier) (GS1, Annual Report 2012-13). All participants in the supply chain with selected standards identify products, thanks to global standards, which are now known as GS1 bar code. The GS1 identification system becomes the base of business processes for most users by creating efficiency in the supply chain. The most important solutions of GS1 are (GS1, About EPCglobal 2012):

- GS1 DataBar is the “reduced” next generation of GS1 bar code. It is smaller than the original bar code, but it may contain more information. According to GS1 survey, the average retail chain with 100 buildings, a GS1 DataBar generates annual operating savings of more than $ 2,320,000 in meat sells.
- Electronic Product Code (EPC) uses tags with radio frequency identification (RFID tags), enabling visibility and efficiency throughout the supply chain and higher quality information flow between companies and their key trading partners.
- GS1 eCom standards provide clear instructions for creating electronic versions of all types of business documents, so that business partners can exchange easily and freely information electronically, regardless of the mother tongue of employees, or sort of internal hardware/software system they use.
- GS1 GDSN (Global Data Synchronisation Network) provides a powerful environment for secure and continuous synchronization of accurate main data about the items and companies.

The GS1 is focused on constant innovation and continuous global language of business because of the development of new digital trends and mobile technologies. The GS1 Source includes the standards based on product information that consumers need in the digital marketing channels. Thanks to the GS1 Source, a network of data aggregators is made to store information about a number of products, with global index that tracks the information. With the implementation of GS1 Source brand owners have the following benefits: increase in sales, brand protection, positive experience, the ability to connect digitally, multi-channel world, providing customers an optimal experience, increase the efficiency of its operations and compliance with national regulations (about benefits on GS1 EPCglobal, 2012). EPCglobal exerts influence on the development of standards for the implementation of the radio frequency identification (RFID) technology in the supply chain in order to meet the needs of all participants in the supply chain.

The EPCglobal identifies automatically information in the supply chain at any location. The EPCglobal network is a framework that allows immediate, automatic identification and sharing of information in the supply chain (GS1 EPCglobal, About EPCglobal, 2012, p. 2). EPCglobal network identify automatically any item in the supply chain in the global market. The reasons for the use of EPCglobal are usually (Thiesse et al., 2011, p. 336): recommendations by an industry association, further (expected) governmental regulations, internal decision process, mandate of a consumer, further (expected) requirements of consumer.

GS1 logistics label provides clear and consistent information to ensure individual monitoring trends in the supply chain about the delivered units. Each logistic unit must be marked with a unique serial number SSCC (Serial Shipping Container Code). The SSCC is used to identify logistics units (in transport and storage), enables individual monitoring of each unit which creates the possibility of implementation a wide range of applications such as docking, shipment routing, automated reception, and the like.

Figure 2 GS1 identification number known as SSCC for identification of logistic units

| Application Identifier | **SSCC** | | |
|---|---|---|---|
| | Additional number | **GS1 company prefix** **Reference unit** | Control number |
| **0 0** | $N_1$ | $N_2$ $N_3$ $N_4$ $N_5$ $N_6$ $N_7$ $N_8$ $N_9$ $N_{10}$ $N_{11}$ $N_{12}$ $N_{13}$ $N_{14}$ $N_{15}$ $N_{16}$ $N_{17}$ | $N_{18}$ |

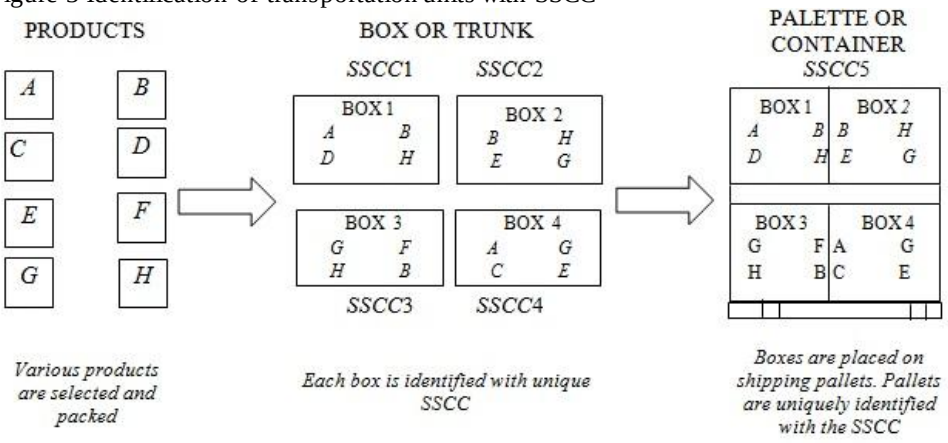
Source: Končar, 2008, p. 100

The SSCC combined with bar coding and EDI technology enable monitoring the transport unit along the supply chain and the full identification of each container and pallet (see Figure 3). The SSCC identifies uniquely each transport package, which is different from the other, during its life circle. Therefore, we can say that the transport packaging makes a special unit, which is completely independent to the sender or, to the recipient. All participants in the supply chain use it, and each shipping container that has specific properties compared to other gets its SSCC (Končar, 2008, p. 101). The SSCC is required data on the logistic label, and it consists of an additional number, GS1 Company Prefix, the serial number and control number (Figure 2).

The GLN (Global Location Number) is used for identification of any locations for the supply chain using. In Serbia, the GS1 GLN organization is a national database and

assigned the GLN to its members. The GLN identifies the physical location of the real entity in order take a single record of the subjects' location.

Figure 3 Identification of transportation units with SSCC




Source: "Coding of Shipping Containers and Pallets: Use of AIs and EAN-128", 1994, p. 8

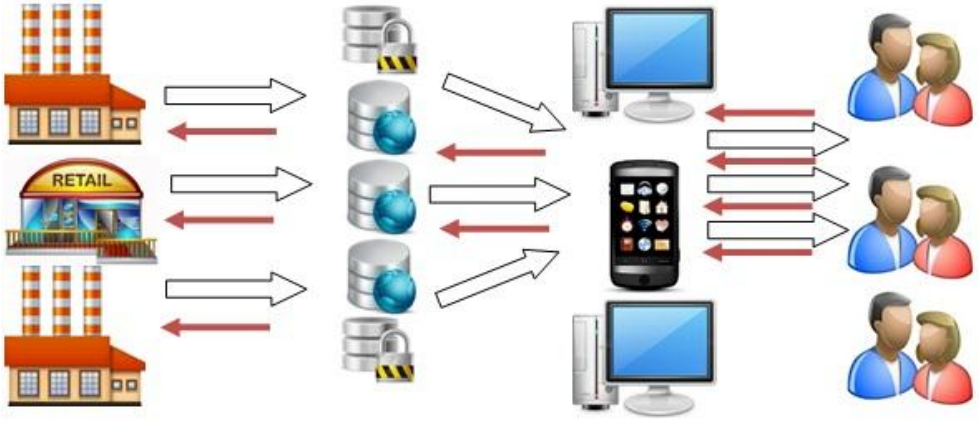
Serial Shipping Container Code is designed in accordance with ISO/IEC 15459 standard, which includes the concept of a unique number to identify logistics units. Regarding the number of trade items, additional information that can be presented and contained in a logistic unit are customer purchase order number, location numbers, and other attribute data (lot number, date, logistical measures, etc.). Identifying and tracking the movement of goods makes the basis of supply chain management, which leads to the increased use of logistic labels in order to follow pallets and other logistics units by the global identification.

## 5. IMPLEMENTATION OF B2C GS1 SOURCE PROJECT OF PRODUCT INFORMATION EXCHANGE

Contemporary supply chains include the involvement of consumers in the exchange of product information. The GS1 Source creates an environment in which it is possible to exchange product information in the digital world. It is based on GS1 standards and the Internet, thanks to which consumers can access to information about the product. For the implementation of GS1 Source, the involvement of all stakeholders is required in the supply chain, from manufacturers, retailers, service providers who create applications for e-commerce and mobile commerce, and consumers that have the requirements for specific information about the product, as well as the government issuing the regulations. In modern conditions, there is some change in the mode of communication between suppliers and consumers. It exceeds the mass communication, and enters various interactive digital methods of transmission of information via the Internet and mobile media. Mobile phones are used for Internet access, scanning bar codes and QR codes, due to which the consumer receives the information about the product and becomes closer to the product.

The communication in multi-channel and digital channel performance is done through GS1 Source, so that product information flows in order to increase sales, because the increasing availability of information leads to more sales. In order to buy online, consumer must have adequate information about the products.

Figure 4 GS1 Source infrastructure




Source: GS1 EPCglobal, GS1 Source, [available at: www.gs1.org/source, access 08.06.2013.]

GS1 Source is based on GS1 standards and a set of stored data. Multi-channel retailers create opportunities for consumers to explore and perform activities of purchase online, thanks to digital availability of accurate information about individual products. The GS1 organization is directed increasingly to the global GS1 B2C Source development of global standards, which has become operational model guidance.

Mobile phone technology allows the consumer to be in contact with the product. The consumer with a mobile phone approaches to products, records the bar code and QR code, and after a few seconds, he receives directly from the manufacturer the information necessary to make purchasing decisions. The GS1 has established a working group GS1 Mobile Com, which satisfying the needs of consumers, manufacturers, service providers and retailers to use mobile phones, which are currently applied to the local market, but still missing the global standards. Consumers come to the information about the product via their mobile phone by scanning. New applications in the mobile commerce will provide consumers a consistent approach to the market via mobile phones.

## 6. CONCLUSION

The position of participants in marketing channels is strengthening in contemporary conditions. In order to have an efficient supply chain, retailers monitor and identify products in collaboration with their suppliers. The focus is on the consumer with tendency to respond adequately and quickly to consumer's needs, altogether with the rationalization

of processes and lower costs. RFID is considered as technology that intensifies cooperation and coordination of the participants in the supply chain. Thanks to RFID the value of information grows and can be easily collected and stored. The GS1 is focused on constant innovation and continuous global language of business because of the development of new digital trends and mobile technologies. The EPCglobal identifies automatically information in the supply chain at any location. GS1 logistics label provides clear and consistent information to ensure individual monitoring in the supply chain. GS1 Source is based on GS1 standards. Multi-channel retailers create opportunities for consumers to explore and perform activities of purchase online, thanks to digital availability of accurate information about individual products.

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# BEERGAME REFERENCE SCENARIOS FOR BALANCED SCORECARD EVALUATION, HIGHLIGHTING INTERNAL PERSPECTIVE

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***Abstract***

In the Szabó-Szoba R&D Laboratory in Győr we use the BeerGame software to demonstrate various supply chain management problems. We have developed this android application in order to have an adaptable, entertaining and effective program, which can provide real life experience to students and industrial partners about the nature of the bullwhip effect, inventory management challenges and create measurable results right away. For the most important part of our trainings and simulations - the discussion of outcomes and the team learning - we use the four (financial, customer, internal, innovation and learning) perspectives of Balanced Scorecard performance measurement system. As a part of our continuous research, in our paper we are focusing on the internal perspective to highlight the specialties of capacity utilization.

**Keywords:** beer game, bullwhip effect, android, Balanced Scorecard, internal perspective

## 1. INTRODUCTION

The Beer Game logistics management game is widely used to demonstrate the inventory imbalance problems in supply chains. In the frame of the game participants impersonate a four stage supply chain (retailer, wholesaler, distributor, factory), and make their own decisions about actual orders in every round according previous demands and expectations. The game was invented in the 1960s by Jay W. Forrester at MIT, as a result of his work on systemdynamics.

The Beer Game has proven to be a very simple, yet effective experiential exercise for teaching the dynamics of marketing and logistics channels specifically and systems in general. Since its invention, it had been played all over the world by people at all levels, from students to presidents of big multinational groups. The factory is responsible for production, and the other three collaborators for distribution towards the customer. The aim of the players is rather simple: each of the four traders has to fulfil incoming orders by forwarding the required units of beer to the partners in the chain with minimal total cost (the charge of inventory holding is 1, in the case of backlog the related cost is 2). Communication and collaboration are not allowed between supply chain stages.

This game can be used in formal education as well as in trainings to simulate real life situations and to highlight the difference between practice and theory by using the learning-by-doing method.

The purpose of the game is to show how the patterns we create in our relations with the world around us may end up with unexpected and undesired results. The game can represent how we (re)act in such trading situations and how these situations lead us into standard ways of "thinking" that we accept without question[10].

## 2. THE BULLWHIP-EFFECT

The competing supply chains are characterized by the ever growing extension. The need of mass-production is increasing in the industry while on the costumers' side the demand of unique goods is extending. These cross-purposes cause the elongation of supply chains and turn them into supply networks with more and more processing, forming, storage stations and resulting in huge transportation and forwarding needs. This system structure has a serious and inseparable drawback, the presence of the bullwhip-effect.

The bullwhip effect is a well-known phenomenon of coordination problems in traditional supply chains. It refers to the effect that the forecast and the actual consumption get separated by the insufficient information sharing. Shortages and huge inventory level show the presence of the bullwhip effect. Even in the case of stable customer demand small changes in orders at the retail end tend to dramatically increase upstream the supply chain.

As a consequence of the bullwhip effect a range of inefficiencies occur throughout the supply chain:

1. excessive inventory throughout the whole supply chain;
2. insufficient or excessive capacity;
3. product unavailability;
4. higher total supply chain cost;
5. loss of revenue;
6. inaccurate production plans.

While the effect is not new, it is still a timely and pressing problem in contemporary supply chains. Bullwhip creates unstable production schedules and that leads to inefficiencies in supply chains, since it increases the cost for logistics and lowers its competitive ability. Companies have to invest in extra capacity to meet the high variable demand. This capacity is then under-utilised when demand drops. Unit labour costs rise in periods of low demand, over-time, agency and sub-contract costs rise in periods of high demand. The highly variable demand increases the requirements for safety stock in the

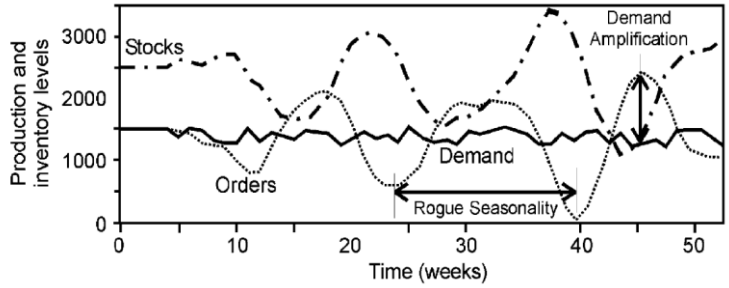
[10] [available at: http://www.masystem.com access 08.09.2013.]

supply chain. Additionally, companies may decide to produce to stock in periods of low demand to increase productivity. If this is not managed properly, this will lead to excessive obsolescence. Highly variable demand also increases lead-times. These inflated lead-times lead to increased stocks and ultimately the bullwhip effect (Bhattacharya et al. 2010) .

Based on many scientific researches the trigger of the bullwhip effect can be traced by the lead time of information and material. A supply chain's reaction on a change in end customer demand is delayed firstly because it takes time to pass on information about the change to suppliers and secondly because these suppliers need time to adjust their capacities and deliveries. The longer a supply chain is unable to react on a changed demand, the heavier it needs to react as soon as this is possible. The bullwhip effect increases with longer lead times. In addition to the lead time of information and material, the bullwhip effect is caused by other reasons:

- Demand forecast based on orders of the succeeding tier
- Historically oriented-techniques for demand forecast
- Batch ordering
- Price fluctuation
- Exaggerated order quantity in case of delivery bottlenecks (Nienhaus et al., 2003).

Figure 1. Demand amplification

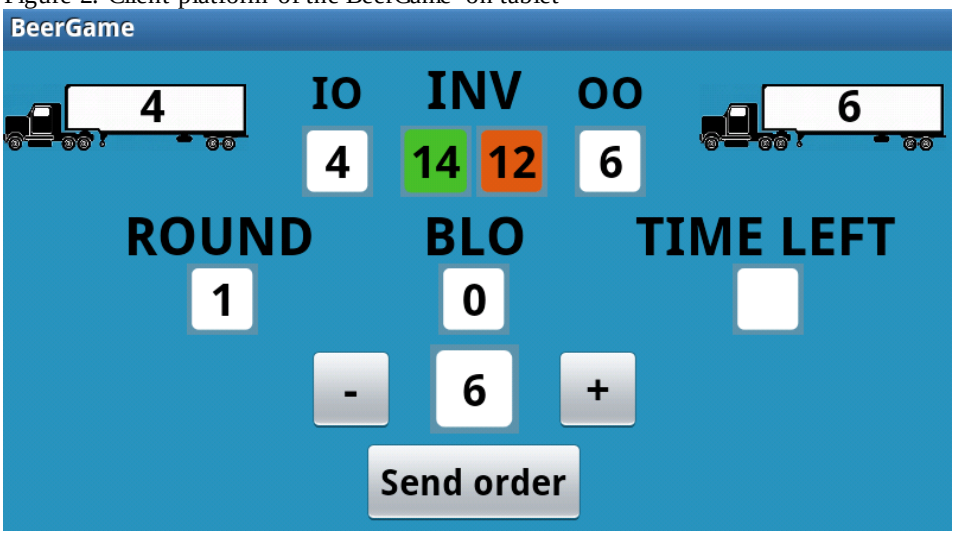



Source: (Towill et al., 2007)

## 3. BEERGAME TRAINING ENVIRONMENT

At the beginning of each game we explain the rules and the main points of the simulation, which represent the usual nature of supply chains. We present the roles, the directions of material and information flows, the charge of inventory holding and the backlog. With the software we developed our trainings last for 24 rounds, which is long enough to see the trends and the challenges, but short enough to not get bored. By this time every participant gets some experience about managing a supply-chain, can observe the difficulties, possibilities, typical tricks and some coincidences. At the end of the game they can share their feelings, experiences and some information with each other - along the supportive lead of the trainer. This discussion is very important in the aspects of recognition and learning.

Figure 2. Client platform of the BeerGame on tablet




Source: tablet screenshot

During the discussions the participants express their typical observations:

- the evolved shortage spreads along the chain
- usually the factory has the biggest shortage and the retailer has the least
- at the half of the gameplay (10-12th round) each of the participants gets frustrated by the appearing backlogs and makes the decisions in panic – worsening the situation
- the period with the shortages is followed by a period with high inventory level
- the bullwhip effect emerges without exception

The time frame usually allows us to have at least one additional full round. In this case the participants are more experienced, they can focus on the discussed and relevant details, they configure some tactics regarding to the consequences. In the second game they usually feel themselves confident and they usually assume that the bullwhip effect at this time won't upset the balance. But is does - in all cases.

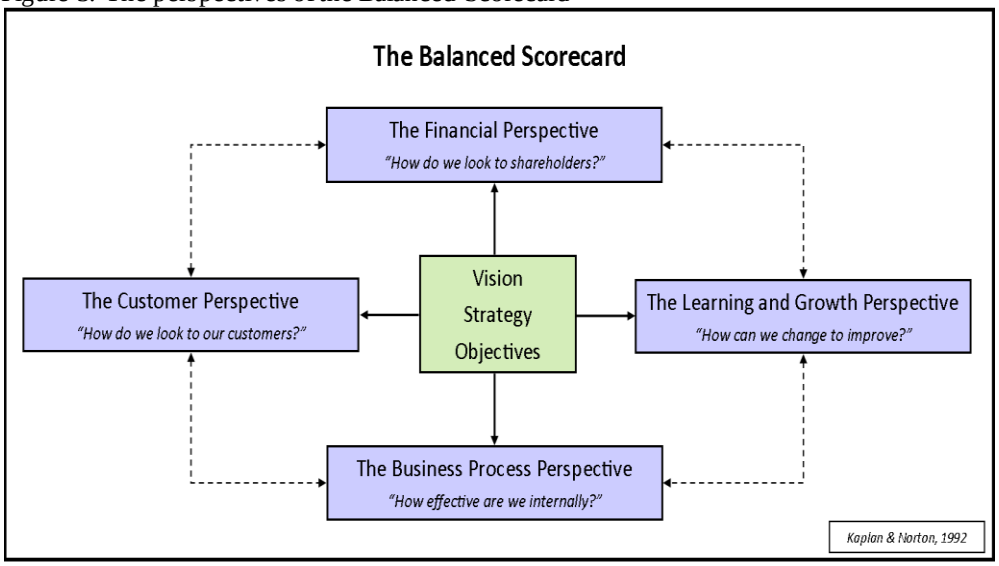
The game - as we can see - is quite simple, the tasks and the functions are easy to understand. Our great advantage is that with the help of the Beer Game android application, the results are available promptly, and game experiences can be discussed right after the rounds. To lead the discussions more detailed, we implemented the Balanced Scorecard measurement system into the application.

## 4. THE BALANCED SCORECARD SYSTEM AS PERFORMANCE MEASUREMENT APPROACH

We had to realize that the traditional efficiency measures by themselves – because they are considering mostly the financial parameters of production processes – are inadequate in providing a complete and useful overview of organizational performance (in our case it means the performance of the whole distribution channel as a system). For better understanding the relations not only on the operational, but also on tactical and strategic

levels, the use of the Balanced Scorecard measurement system is widely accepted: it is operating on the financial, marketing (customer-related), operational (internal-business processes) and strategic dimensions (learning and growth).

Figure 3. The perspectives of the Balanced Scorecard




Source: [available at: http://cowanglobal.com/tag/balanced-scorecard access 08.09.2013.]

A typical BSC consists of four perspectives - financial and non-financial measures to guide implementation and evaluation: financial, customer, internal processes, and learning/innovation, in addition focuses both on the short- and long-term objectives of the organization (Chopra & Meindl, 2001).

The financial perspective is the basic of the BSC measurement system. It has a lot in common with the typical measurement systems, and that's where the easiest to create KPIs. The truth is that managers will always want to see clearly the data, trends, graphs, and use every possible instrument to learn where the company is heading to, be aware of the risk assessment and cost-benefit data. This is why it's colligated with the other three perspectives, to help us to see the whole picture. We can generate the most obviously measurable indicators in this area, accurately calculate the inventory holding cost and the penalty in case of shortage, capital tied up in inventories, frequency and amounts of out-and in stores, storage costs (depend on the size of the warehouse and the storage technology).

The next factor is the customer, who – in an ideal supply chain- always should be satisfied. The management have to realize that the future of the company depends on the strong loyalty of the partners. Applying indicators on customer satisfaction may show hidden problems before our partner changes supplier. A possible way is to separate our customers in different groups, and rate their different needs, and then customer service can get closer and closer to their needs. In this case customers are mostly the trading partners, who order from our inventory.

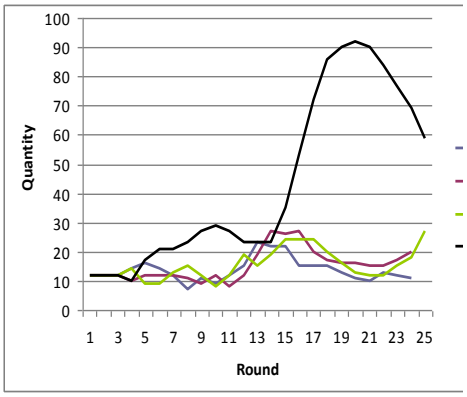
In order to be successful the internal business processes must be continuously improved and examined. It makes it easier for the employees to perform their tasks, minimize the possible mistakes and the managers can see the quality of the production or

services. The problem with this perspective is that it requires very profound knowledge about every tiny detail of the internal business processes, so it cannot be developed by an external consultant or expert. The internal processes of distribution channels contain lots of components. Forecasting, human and material resource planning, production and shipment scheduling can largely influence the efficiency of the company, and globally the performance of the chain. Usually, it is hard to find the real optimum, meanwhile it is possible to fulfil the demands by using different logistics strategies

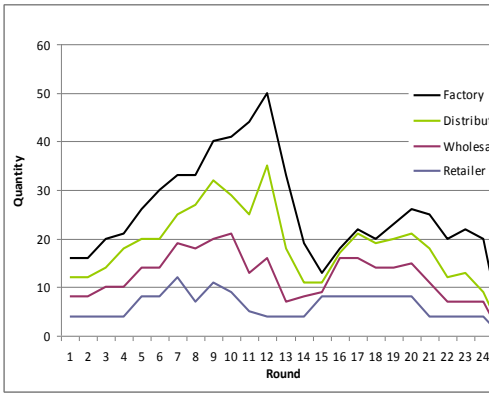
The last perspective is the innovation and learning. It both means the training of the associates and the self-development of the company. With the current technical improvement speed, no one can afford to miss out these aspects. Employees have to be updated and evaluated during their work, and companies are advised to build databases of specialized knowledge. The level of technical developments can be measured by adequate metrics (physical and quality indicators). Those indicators allow companies to see how fast they can comply with new techniques, trends, and the fluctuation of the customer demands. (Skurkova et al., 2012).

With the BeerGame software we are able to create graphs to demonstrate the bullwhip-effect and its consequences regarding to the four BSC perspectives. The typical results are shown below:

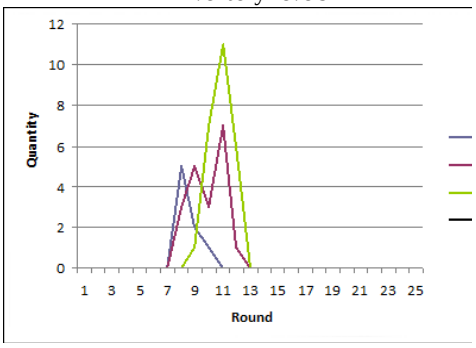
Figure 4. Illustration of the bullwhip phenomenon



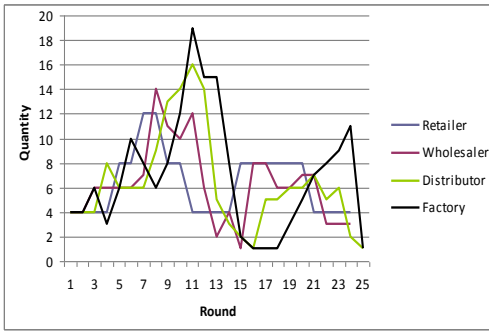

Inventory levels




Outgoing shipment




Shortages




Incoming orders

Source: own study

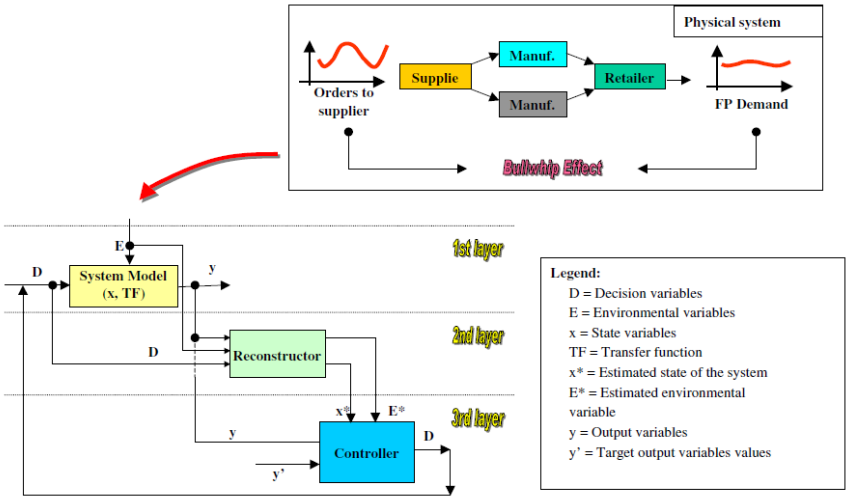
## 5. INTERNAL PROCESSES

**New taxonomy:**

A very interesting research at the Technical University of Milano introduces a twofold distinction between layers (physical, reconstructing and control levels) and mechanisms (determinants and triggers), whose interaction may lead to the Bullwhip Effect. The aim of the article is to make the managers and researchers able to classify, understand and explain the causes of the undesired behaviour, and to understand which interventions (on which mechanism and on which layer) could be more effective in reducing the consequences.

1. System Model: the supply chain's physical structure, including the operative processes (production, transportation, etc.) and its decisional and environmental variables.
2. Reconstructor Layer: all the methods (processes and systems) used by managers to estimate the state of their own business: the forecasting system, the accounting system (consumption of company's resources) and the performance measurement system (distance between the company objectives and its current achievements). The author highlights the difference between this three-layered framework and the standard framework in Control Theory textbooks, because this layer also contains the output measurement processes.
3. Controller Layer: the third layer includes all the models, heuristics, intuition, etc. used to manage stocks, production activities, and delivery plans and so on.

Figure 5. Three-layered modelling of supply chain processes




Source: (Miragliotta, 2006)

The second concept presented by the author is stability. The stability of a linear system is analytically defined by observing the free response of the system. „This means that the property of being stable has to be checked by triggering an initial perturbation (directly in the state of the system, rather resorting to an external input) and then observing the reaction of the system (Miragliotta, 2006). We can see on the following table how he applied the stability concept on his bullwhip effect study.

Figure 6. Determinants and triggers of the bullwhip effect

| Supply chain - Proclivity to the BE | | |
|---|---|---|
| **Determinants** | | • Delays & Feedbacks<br>• Irrational Decision Making<br>• Batching (Quantity / Frequency)<br>• Modelling Errors |
| **Triggers** | **Internal** | • Process Uncertainties:<br>o Machine Reliability<br>o Process Capability<br>• Measurement Errors |
| | **External** | • Upstream:<br>o Supply reliability<br>• Downstream:<br>o Price Promotions / Advertising Campaigns<br>o Shortage Gaming<br>o Financial Deadlines |

Source: (Miragliotta, 2006)

As a result of his research he combines the System Thinking and the Management Operations schools into a new taxonomy of the bullwhip effect:

Figure 7. New taxonomy for the Bullwhip Effect

| | Determinants (redesign actions) | Triggers (filtering actions) | |
|---|---|---|---|
| | | Internal | External |
| Physical layer | Linear gain<br>Delays & feedbacks<br>Batching (quantity) | Machine reliability<br>Process capability | Supply reliability |
| Reconstructor layer | Delays + modelling errors:<br>In accounting<br>In forecasting<br>In measuring performances | Measurement Errors:<br>In accounting<br>In forecasting<br>In measuring performances<br>In accounting | |
| Control layer | Batching (quantity, frequency)<br>Delays (in the control model)<br>Irrational decision making | | Price promotions/advertising<br>Campaigns<br>Shortage gaming<br>Financial deadlines |

Source: (Miragliotta, 2006)

This new taxonomy was directly derived from the existing scientific literature. What makes it special is its completely new viewpoint - which shows us how the various elements were united -, and its attitude, which builds a bridge between theory and practice. Their aim was to draw attention to renew, revive and rejuvenate the scientific debate about the causes and the mechanisms of the Bullwhip Effect. He concluded that a ‘‘new

generation of Beer Games'' should be developed. The researchers should take not only the ordering processes into consideration, but every process and every factor which may trigger, or determine the Bullwhip Effect (Miragliotta, 2006).

The internal processes of distribution channels contain lots of components. Because of that it shows presence in most of the fields of the new bullwhip effect taxonomy. Forecasting, human and material resource planning, production and shipment scheduling can largely influence the efficiency of the company, and globally the performance of the chain. Based on the experiences we can say it's a good way to treat the whole supply chain as one system. If we consider the factors globally, and we treat the whole supply chain as one system, we certainly can get closer to the optimal solution. Several questions may arise elated to the internal processes:

- How much information do we share with the partners?
- Do we discuss our trading plans with our supplier?
- Are we able to manage a common inventory or trading plan with the others?
- How efficient is our capacity utilisation?
- Do we have idle resources in the shipments?
- What kind of forecasting method leads to the optimal resource allocation?
- What is the ideal safety stock level?

The consequences of bullwhip effect are increasing total cost of supply chains, lower profit rate, and loss of competitiveness. The inappropriate usage of resources implies the increasing logistics costs and declining customer service and its adverse effects which worsen the performance of companies and supply chains.

For the investigation of this perspective we used the following equations and had the results below:

Figure 8. Equations used for Internal processes perspective

| | |
|---|---|
| Maximum Inventory Level | $INV_{max} = X_{i\ max}$ |
| Average Inventory Level | $AINV = \frac{\sum INV}{n}$ |
| Maximum Shipment | $Sh_{max} = X_{i\ max}$ |
| Average Shipment | $ASh = \frac{\sum Sh}{n}$ |

Source: own study

Figure 9. Results of sample BeerGame

| **Internal** | Retailer | Wholesaler | Distributor | Factory |
|---|---|---|---|---|
| Maximum Inventory Level | 22 | 38 | 50 | 38 |
| Average Inventory Level | 14,79 | 14,13 | 17,75 | 11,92 |
| Maximum Shipment | 12 | 11 | 15 | 20 |
| Average Shipment | 6,33 | 6,5 | 7,58 | 9,17 |

Source: own study

The inventory levels at different points of supply chains vary separately from the real costumer demand because of the bullwhip-effect. The usage of resources as production-, distribution-, and warehousing capacities may easily become not effective. (Bhattacharya, 2010).

On the previous table the maximum and the average levels differ strongly in both cases, inventories and shipments. These data clearly shows the common logistics trade-off situation which the management typically have to face when designing the capacity of warehouses and cargos.

For example, while comparing the Maximum -, and the Average Inventory Level we can see significant differences, for example at the Distributor and the Factory. It is a waste of resources to start a warehouse-extension investment to establish a warehouse regarded to the highest stock occasionally - then "store air" on the shelves most of the time; or otherwise, they have to calculate the additional costs of "external storing" the extra stock. The company needs to be clear with the capacity requirements according to their "safety/risk" preferences.

The same applies for cargo capacities, where we may notice huge differences between the maximum and average demands.

## 6. CONCLUSION AND FURTHER RESEARCH

The main challenges of modern logistics and supply chain management are: providing high level quality service for customers according to the ever-growing and ever-changing demands, optimizing low series production and distribution in various environments, managing stocks in lean and agile production systems, eliminating the bullwhip effect, applying different trade-off solutions for minimizing infrastructure investment, distribution and warehousing costs and maximizing capacity utilization. The wide variety of products, the challenges of fluctuating demand, the appropriate inventory management and the application of modern production and distribution strategies requires flexible innovative thinking and special management skills from experts: to construct and manage effective, well-balanced manufacturing and distribution process in supply networks.

The BeerGame environment is excellent for training university students and experts from the economy to get these cooperative and innovative skills. During the trainings, the importance of Balanced Scorecard methodology is coming from theory into practice and participants can get real-life experience about the construction and operation of logistics performance measurement systems. In this article we were focusing on the internal processes perspective of the Balanced Scorecard performance measurement system. We can conclude, that while examining the performance of the supply chain, we always have to consider the logistics trade-offs as well.

In our further research we are focusing on the specification of typical "incoming order" patterns – derived by the expert trainings – and some "best practice" inventory management samples.

## 7. ACKNOWLEDGEMENT

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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# IMPLEMENTATION OF A VISUAL KANBAN METHOD FOR PROCESS MANAGEMENT IN THE GRETA ENVIRONMENT

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***Abstract***

GrEta is an innovative simulation project, what was constructed in Szabó-Szoba R&D Laboratory at Széchenyi University Győr, for modelling the nature of flexible production processes. It is one of the best ways to demonstrate the most commonly occurring logistics phenomena in series of mass production on the learning-by-doing way. As the latest development in the GrEta environment we applied the visual kanban method to highlight the difference between push and pull production systems. The GrEta plotting board is also equipped with an automatic time measurement system, to register all the data the participants need to form KPIs, create an adaptable evaluating scheme and support the decision making process. The aim of this paper is to sum up the theory of kanban and to describe how we integrated it into the GrEta plotting board as a new phase of the development of our learning-by-doing training environment.

**Keywords**: production process modelling, kanban, learning-by-doing, performance evaluation

## 1. INTRODUCTION

The main challenges of modern logistics and supply chain management are providing high level quality service for customers according to the ever-growing and ever-changing demands, optimizing low series production and distribution in various environments, managing stocks in lean and agile production systems, eliminating the bullwhip effect, applying different trade-off solutions for minimizing infrastructure investment, distribution and warehousing costs and maximizing capacity utilization. The wide variety of products, the challenges of fluctuating demand, the appropriate inventory management and the application of modern production and distribution strategies requires flexible innovative thinking and special management skills from experts: to construct and manage an effective, well-balanced manufacturing and distribution process in supply networks (Bajor et al. 2011).

The learning-by-doing method, based on personal experience (dialectic approach) is able to help in the education and training to get these innovative and cooperative skills.

The main purpose of our innovative LEGOstics simulation projects is to construct special real-life environments for modelling logistics systems and phenomena (the nature of product and information flow in a supply chain, the meaning of delivery in time shipments, material handling and order picking processes of a warehouse or a factory, flexible manufacturing, work-in-process inventory management, lean thinking, etc). During the learning-by-doing LEGOstics trainings participants can get practical knowledge and develop many innovative skills to be able to construct, design and re-engineer sustainable and efficient logistics processes. They can understand the importance of observations and measurements in logistics, and they feel the responsibility of making decisions (Makkos et al. 2012). In this creative learning environment all the actions are provided by participants – with flexible, dialectic (learning-by-doing) ways, focusing on evaluation results and the whole process of performance measurements.

We are developing all these environments on the same platform: analysing and developing the processes according to the technology and real nature of logistics processes (warehousing, material handling, production and transportation).

After presenting the basic concept of GrEta environment (second chapter) we give a short summary about the theory of kanban, then we are going to describe the integrated developments in the fourth chapter.

## 2. THE GRETA ENVIRONMENT

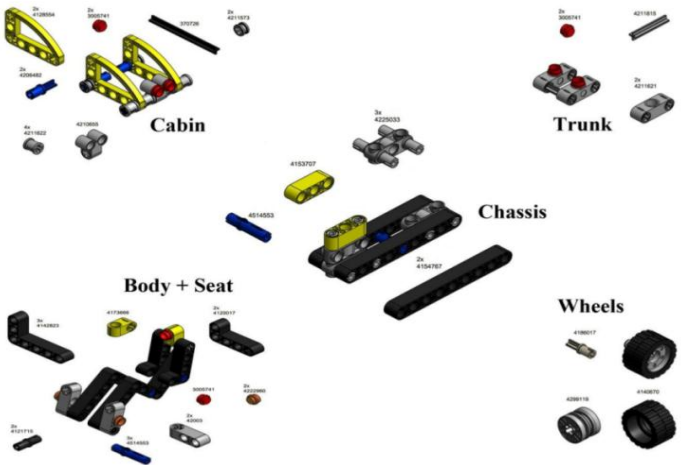
The GrEta car is a self-developed, non-official LEGO product, based on our intention to construct a relatively simple model, which can be built up differently and in totally flexible ways (Figure 1). The result is GrEta (E is a capital letter which represents Eta – efficiency or effectivity).

Figure 1: GrEta car

Source: Makkos-Káldi et al., 2012

**GrEta car** has 8 separate functional parts: chassis, wheels, engine, engine hood, seat, computer unit, cabin, lamps (Figure 2). The parts also can be assembled on some ways. The participants have a lot of possible strategies and production system structures, according to the decisions of the team based on the different personal attributes. (Makkos et al. 2012)

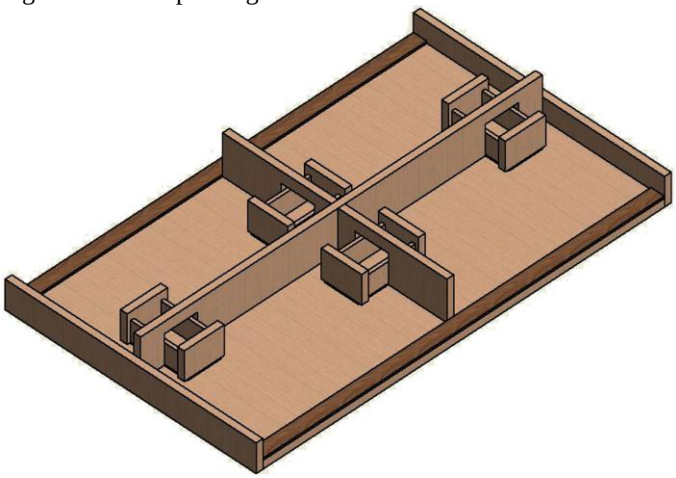
Figure 2: GrEta main parts




Source: Makkos-Káldi et al., 2012

The GrEta plotting board is basically a regular wooden board, which has been separated into four workstations (Figure 3).

Figure 3. GrEta plotting board



Source: Makkos-Káldi et al., 2012

Between the workstations we situated four drawers for transportation. In the game the transportation has the highest priority, when a box (shipment) comes it always has to be unloaded and sent back to the previous participant to provide the possibility for the continuous material flow (Szander et al., 2012).

## 3. KANBAN

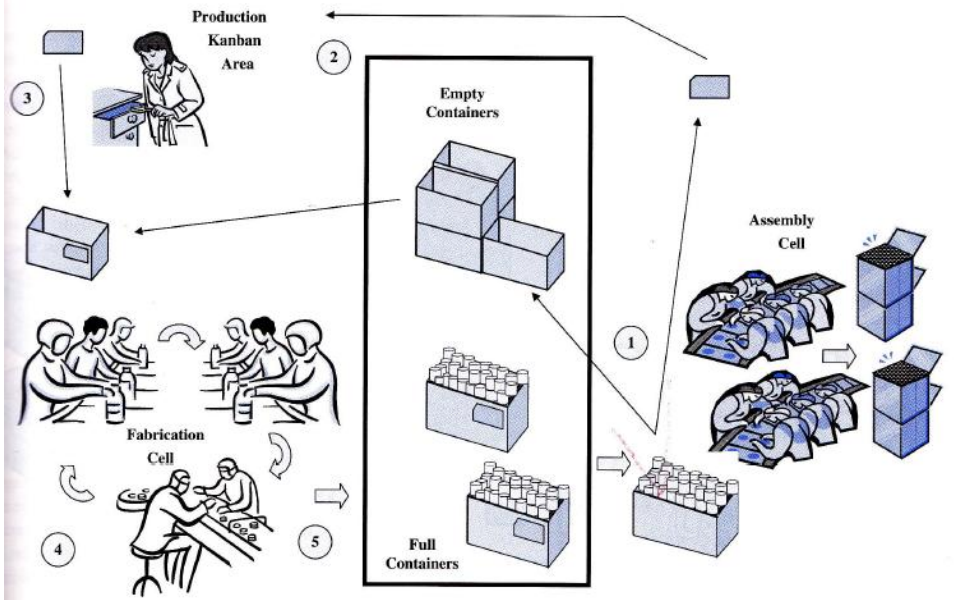
The kanban is very popular in nowadays productions, so that we added visual kanban system to the GrEta plotting board to modell this kind of production environment.

Kanban – a signaling system used to trigger upstream order releases in a pull scheduling environment. Typically cards are used as the signaling medium – however, other devices such as plastic markers, balls, or empty containers have been used.

In a kanban system, the flow of materials is controlled using a method by which workstations can exchange signals when one is about to run out of material. By pulling rather than pushing material through the plant, work is produced only as needed. There is no longer the time-bucket constraint and an entire production batch does not need to be completed before material can be transferred to a subsequent workstation. Kanban containers have a size that can be manually transported between workstations permit small quantities of materials to be transferred to the next operation as soon as a container is filled.

Two types of kanban card systems are common – the single-card and the two-card systems. The single-card system, illustrated in Figure 4, works well when two sequential workstations, or manufacturing cells, are in close proximity.

Figure 4. The single-card system



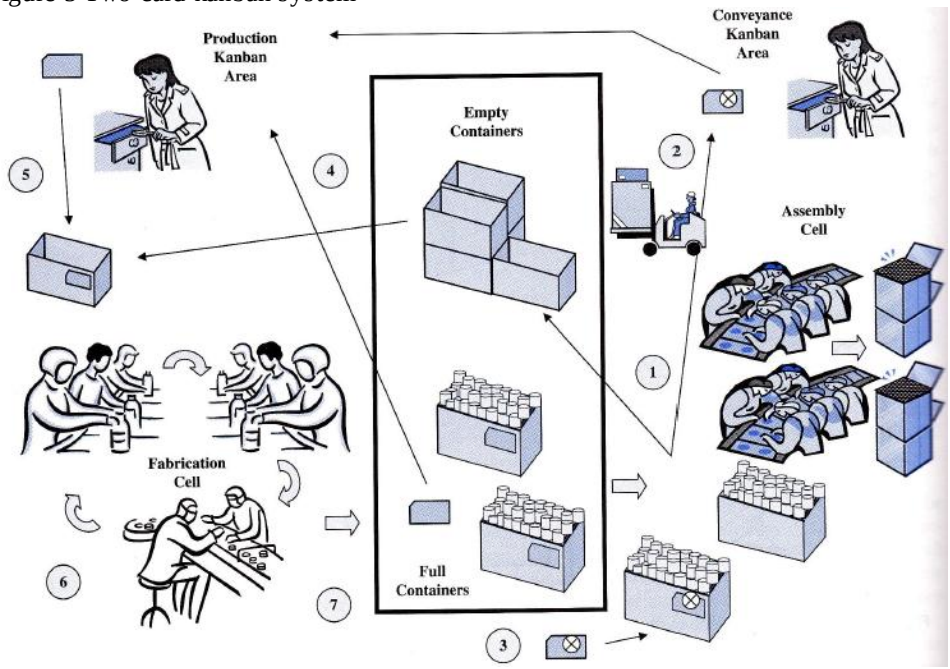

Source: Aikens, 2011.

The sequence works as follows.

- When the assembly cell empties a container of parts, an operator returns the empty container to the storage area and withdraws a full container.
- The kanban card is removed from the container and returned to the production kanban post as a signal to the upstream fabrication cell to produce more parts.
- An operator from the fabrication cell will take the card from the production kanban area and withdraw an empty container from the storage area. The card is then attached to the carton.
- The fabrication cell completes the order.
- When the container is full it is moved, with the card still attached, to the staging area waiting to be withdrawn by the assembly cell.

A two-card system is illustrated in Figure 5 and is necessary when the two sequential operations are not close.

Figure 5 Two-card kanban system




Source: Aikens, 2011.

This system uses a conveyance card and a production card. The two-card sequence works as follows.

When the assembly cell starts to work on a container the conveyance card is removed and taken to the conveyance card post, where it is retrieved by a material handler.

- The material handler then goes to the storage area where a full kanban container is withdrawn and removes the production card from the container. The handler then replaces it with a conveyance card.
- The full container, with conveyance card attached, is then transported to the material staging area in advance of the assembly cell.
- The production card is taken to the production post.
- The production card is withdrawn by a fabrication cell operator as a signal to produce more parts. The operator withdraws an empty container from the storage area and places the production card on the container.
- The fabrication cell then proceeds to fill the order.
- When complete, the full container with production card attached is transported to the storage area.

A kanban signal does not have to be a card nor does the signaling medium even have to be written. Any kind of visual signal can suffice. Rolling colored golf balls down a chute, hoisting a flag, or using a semaphore style code can all be effective means for communicating. One simple form of kanban involves painting a square on the floor or taping off a designated area on a workbench between two operators. When material occupies the square the upstream operator does not produce. When the material occupying

the area has been depleted, the upstream operator knows that it is okay to start producing again.

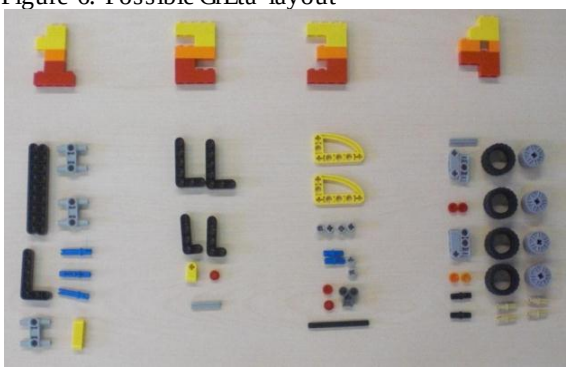
A variation of kanban assigns jobs a priority using a system of distinguishing colors. For example, if red is used to indicate top priority, operators would be instructed to process red cards ahead of other colours (Aikens, 2011).

## 4. TRAINING SCENARIO

The GrEta training was constructed for four participants, but it also can be played by eight or more people. as we created a flexible training method. (As an example, for 8 participants we create two groups, like 4 people are sitting and assembling, the rest stay close to observe and measure, then they change positions in every round. It is very effective, because all assembling positions have a worker and an observer, every participant can practice the tasks and also see through the whole process – finally they can get more attractive ideas for process development).

We prepared a step-by-step individual assembling guide for participants, because it is inevitable to have experience in the assembling of all parts and the final model as well. In the instructions guide we separated the assembling tasks into four different steps, which we use later as the first layout in the game.

Figure 6. Possible GrEta layout



Source: Baladincz et al., 2012.

In the following phase participants are situated around the plotting board, and start the assembling with the initial layout in series mode (no parallel working). They are preparing only one model on this sequential way four times, while they change the positions in each round. This way every player gets the experience about each task, and is also able to observe the adequate and the insufficient points in the procedures.

They need to be clear with the rules, which are the following:

- The tasks should be performed independently.
- No elements exchange between the positions (players have to follow the previously discussed scenario in each round).
- Priority of the transportation (unloading and returning the boxes):
- Documentation (register every detail which is considered to be relevant).
- Quality checking.

- Discussing remarks, problems, ideas round-by-round.
- Decision about the layout.

After the sequential assembling practice they can start the mass production. They have to choose a boss from the group who will be responsible for the layout, the tasks and the whole process. In the first round of parallel assembling the participants use the basic layout what can be changed after the discussion. The most important part of this round is to declare the performance measurement requirements. They also have to decide what to measure, and how to measure, because this will be the base of the following optimization.

During the training participants can get experience about production teamwork (allocate procedures according to different features of a given workstation – speed, accuracy, quality checking, etc.) and also in process analysis (after a round they discuss their observations, make some changes, do it again, evaluate the consequences, etc.) The main questions are: What is the real meaning of efficiency at a given case? What to measure and how to measure? How to improve capacity utilization? How to fit different processes following each other on the best way? (Baladincz et al., 2012).

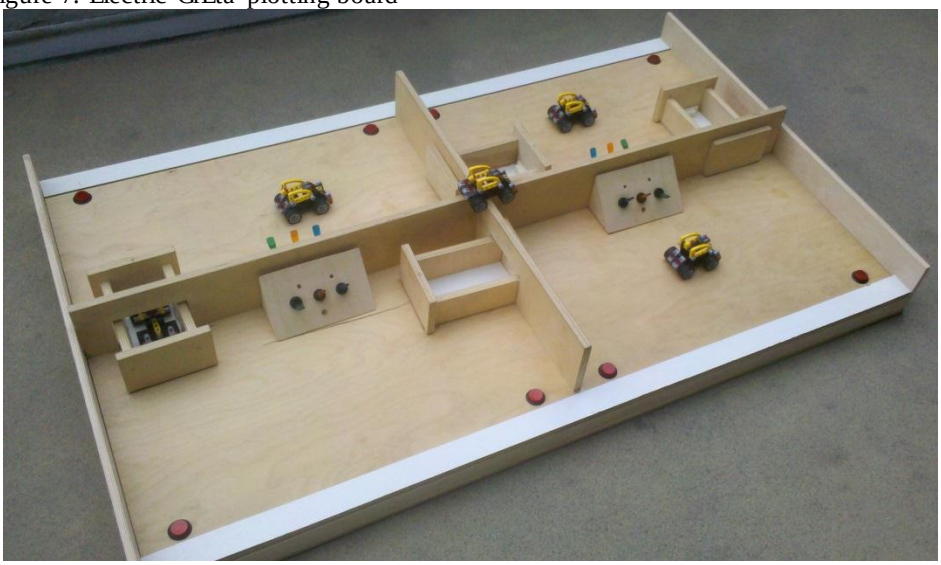
The participants do not compete with each other – their job is to improve productivity and provide high-level quality checking at the same time (measurements, quality check points, etc.)

Until the new phase of the development the production worked in push system: if somebody was ready with the task the semi-finished product was forwarded to the next assembler who had to unload the transport box and send it back immediately. At this point they had to choose: start to assemble the elements on the arrived semi-finished product, or get back to the interrupted process.

With the new electric GrEta plotting board we're also able to simulate the production method in pull system with visual kanban. When a position is ready to receive material they switch a lamp on, signalling to the previous position. In that way the products will arrive in the right time and the assemblers don't need to interrupt other process to deal with the arriving shipment. In this way the production can be continuous the participants can work with better circumstances. One relevant difference can be the stockpiling. With the kanban system the stockpiles emerge at a certain position, they can't just push it to the next participant's area – one piece they can store in the transport box, but the following pieces must be handled other ways.

Every position has three switches to sign the need of material in both directions. The third one is used for the bulk production, when they need more of the basic elements – when the light is on, the "supplier" who's not sitting at the table will deliver the matching pieces. The continuous manufacturing is one possible development way for the GrEta plotting board. We also integrated 2-handed idle-time buttons for the detection of inactive periods at each player. At the end it is possible to compare not only the lengths of inactive periods, but the distribution of inactivity in space and time as well. We are using magnets and reed-relays for the monitoring of transport activities. We put a magnet at the bottom of one side of each transport box, and a reed-relay under the box – the logical value is 1 when the magnet is closed to the reed-relay, if it is far the value is 0. It is possible to import the results into a CSV file, where we can easily make graphs, and analysis. The micro-controller and all the wires are situated under the table – so that they won't disturb the assembly. We can see the Electirc GrEta in the next picture.

Figure 7. Electric GrEta plotting board



Source: own photo

This way the participants can actually experience how do the push-, and pull systems work, the differences, pros and cons of both ways of production processes and they can get a picture about the operations and specialities. Thanks to the automatic time measurement system we can register every data, after the game the participants can see actually theirs and the system's performance.

## 5. CONCLUSION

Laboratory of LEGOstics is an innovative (low-cost) learning-by-doing environment for students, experts and researchers from the field of logistics. In the GrEta manufacturing environment all the assembling and re-engineering actions are provided by participants according to the goal: reduce the time request and improve the productivity rate of the mass-production system.

During the training it is possible to highlight the importance of logistics process re-engineering and develop the critical skills of participants to be able to:

- recognize the critical factors of production processes
- construct appropriate performance measurement systems
- support the decision making process of system developments

Adding the kanban feature to the plotting board can be effective in formal education for deeper understanding the theory in learning-by–doing way. The participants can realize in practical environment the impact of changing systems, processes in production systems. The biggest advantage of using kanban is the automation of replenishment processes; actually the system can manage itself if the constructed environment is properly built.

As a further research direction we are going to apply the Balanced Scorecard performance measurement system in order to help the participants to understand how they can create a measurement frame for production processes.

## 6. ACKNOWLEDGEMENT

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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# MONITORING THE ORDER PICKING PROCESSES WITH THE ELLI3 MEASUREMENT TOOL

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***Abstract***

Order picking is one of the most time-consuming activities in warehousing. Having appropriate measurements and accurate data about the real time-requests of different operations like travel time, searching and picking time or setup time is inevitable for making the decisions about further logistics process developments. These parameters and the correspondence between them can be unique in each warehouse. We are developing the Elli3 tool for this measurement and monitoring purposes in Szabó-Szoba R&D Laboratory at Széchenyi University Győr. The Android-based Elli3.COM program is running on tablet which is extended by a professional bar-code reader for the automated identification of locations. In our essay we present the first successful application of the Elli3.com tool at a warehousing company.

**Keywords:** order picking, time request measurement

## 1. INTRODUCTION

Modelling has key role in logistics system design and further development. Based on models and simulations it is easier and cheaper to discover problems and bottle necks of logistics processes. Furthermore these are the only objective methods to find optimal and adaptive solutions, or test the available alternatives (Bódis at al. 2012).

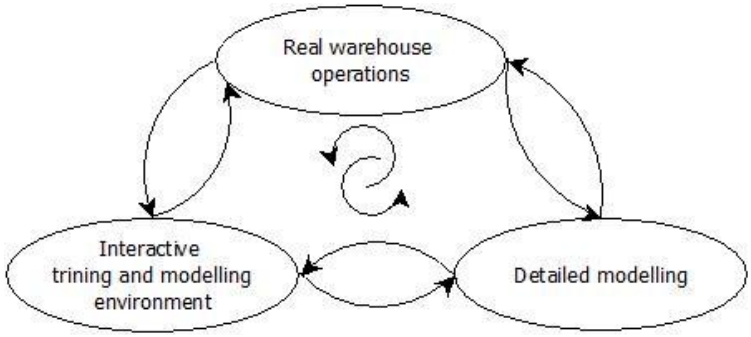
Every modelling process should start with measurements, when the modelled system, processes, problems and possible bottle necks are measured and get to know. After the modelling it makes the development team able to validate the designed model.

In our essay we present an innovative consultancy cycle and the Elli3 measurement framework what are developed in Szabó-Szoba R&D Laboratory at Széchenyi University Győr. We will concentrate on the measurement of the logistics processes. After describing the Elli3 equipment we will introduce the first successful application at distribution warehouse on the field of order picking. We will present the detailed measurement and evaluation of order picking process as a case study.

## 2. INNOVATIVE CONSULTANCY CYCLE

The measurement and evaluation of the real warehouse is usually the first step of the innovation processes. The deep knowledge of the developed system is essential. It is required to the effective and usable results of the logistics re-engineering processes.

Figure 1: Consultancy cycle of innovation




Source: Bódis et al. 2012

Sometimes the measurements start after an interactive training. The main aim of this previous training is to get to know the actual solutions, processes, best practices and problems together with the partners. They can also realize the importance of innovation.

The interactive training and modelling environment have couple of functions during the innovation cycle, where the plotting board and the computer simulation are synchronised. This is the field of the active cooperation between consultants and partners.

During the detailed modelling processes the consultants make much deeper computer based simulations about the previously prepared and evaluated alternatives. These models are constructed with real scaled layouts and running with detailed programmed algorithms. These can test long time intervals and computationally intensive solutions. Furthermore it is possible to automatically generate all kind of statistics to compare alternatives.

The innovation and development projects are never linear process. These require continuous feedbacks and round by round development. In my consultancy cycle, each element has two-way cooperation with all of the other elements. Each element has special added value for the processes. The final solution has to work in the simulation model, has to be visible and understandable in the interactive environment and has to be valuable and

usable in the real system. The development and the fine-tuning processes are impossible without continuous round-by-round tests and feedbacks (Bódis at al. 2013).

## 3. ELLI3 MEASUREMENT SYSTEM

On the way of modelling and simulation the first step is having the appropriate data. That is why the innovation process starts with the measurement of the actual system. Elli3 is an android based application developed in Szabó-Szoba Laboratory for monitoring the time request of all pre-defined warehouse operations with automatic time stamps. The examination of the workflow display-interface is adapted to the pre-defined actions appears to be measured - the assessor will tap to activate each key, and the device records the sequence of events with timestamps. (Bancsó et al. 2013)

By using our Elli3 tool we can discover many hidden parameters of product and information flow. Based on the results and analysis we can classify the main features of the operations and the product structure.

The Android-based Elli3 applications are running on tablets supported by bar-code reading tools for the automated identification. During the measurement the application is logging the time interval of the previously defined movements (i.e.: searching, counting, administration...). Furthermore it is possible to read any standard barcode to support the later data processing, it makes us able to merge the measured and the partner's data sources.

In the following chapters, we will describe the general Elli3 framework and the protocol of warehouse measurement.

### 3.1. The aim of the measurement

The main aim of the measurement is to get experiences about the system characteristics, exact algorithms, collect time requirement and parameters for modelling the measured logistics systems.

The measurement is essential to get the real warehouse model and find easier the problematic aspects of the warehouse.

The proper quality and quantity data processing, discovering the links can give us proposal to create a measurement method. It shows us the time requirement ratio and tells which operation's optimization is necessary.

### 3.2. The Elli3 protocol

The measurement is always compatible with the particular warehouse, its process and special problems. After the warehouse is mapped, we make a flow diagram about the system in order to get the total view. This diagram helps us to build up the system. When we have the Elli3 application to the specific warehouse the next step is the testing phase. If something is wrong, we correct it until it will not be completely good.

In the frame of the general measurement process the measurement people follow the operator worker and measure his work. It is important to make sure, do not bother him in his work. Just measure, observe and get detailed information about the process.

### 3.3. Output and evaluation

During the measurements 2 types of *.csv are generated for each measured event (i.e.: for each picking process). One of the files contains the logged event with time stamp and interval. The other file contains the read barcodes with time stamps.

Further input data for the analysis are the material data, WMS log files and layout. The measured data will be merged with the partner's data sources and analysed the actual logistics system.

The measured process operation:

- Receipt of goods (Elli3.gin)
- Homogenization
- Store in, upload picking position, over storing to the picking position (Elli3.sin, Elli3.uld)
- Picking (Elli3.com)
- Palletisation
- Final control (Elli3.fin)

The previously assumed context regarding to the "loading of goods" processes (homogenization, to storage, order picking, assembling)

- The operation time is depends on the quantity specifics:
  - Number of pieces
  - Collection unit (the collector volume or per unit can be met)
- The operation time is depends on article characteristic
  - Entity/Unit (collectively or pieces) geometrical dimension (volume, aspect ratio)
  - Unit weight
  - Unit manageability, tangibility, etc.
- The operation time is depends on storage space features
  - Storage space level
  - Availability of storage space

## 4. CASE STUDY OF ELLI3.COM APPLICATION

We measured the picking process in a distribution warehouse, and we used the Elli3.Com application what we adapted to the given warehouse process.

The basic warehouse operations depend on the actual physical conditions, characteristics, but also on the degree of correlation. The individual factors are not known, in different warehouses it can be substantially different. The measurement perform is indispensable because the simulation program runs during these basic operations occur in great numbers, and if the estimated data its incorrect, the accuracy of the simulation can significantly reduce.

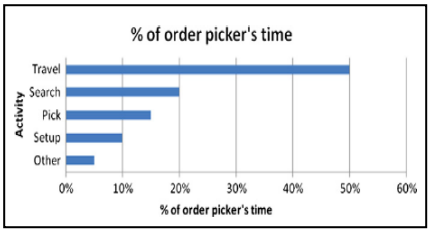
Order picking has long been/has been long time identified as the most labour-intensive and costly activity for almost every warehouse; the cost of order picking is estimated to be as much as 55% of the total warehouse operating expense. Any underperformance in order picking can lead to unsatisfactory service and high operational cost for the warehouse, and

consequently for the whole supply chain. In order to operate efficiently, the order-picking process needs to be robustly designed and optimally controlled (Koster et al. 2007).

Order picking is one of the most time-consuming activities in warehousing. Having appropriate measurements and accurate data about the real time-requests of different operations like, travel time, searching and picking time or setup time are necessary for making the decisions about further logistics process developments. These parameters and the correspondence between them can be unique in each warehouse.

The order picking time is influenced mainly by moving, searching, picking and unit load building time. According to the scientific literature the most crucial parameter is the travelling time, which gives the 50% of the whole picking time (Koster et al. 2007).

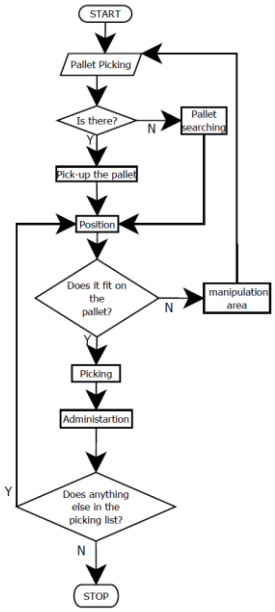
Figure 2: Time distribution of order picking movements




Source: Chan et al. 2011

First of all we investigate the picking processes to see the global view, and we made the flow chart about the process. The exact description of the process played an important role in the preparation of the application.

Figure 3: The picking flow diagram sample




Source: Baladincz et al. 2013

In the Elli3.COM measurement application we separate the processes about the commonly used terminology: Travel (transport, travel, motion) , Pick ( picking), Search (search, identification), Setup ( palletisation) and Other.

The picking worker get the picking list and with the jet (automatic pushcart) he will go and pick all the goods what he has on the picking list. When he finished he should put the pallet with the goods in the control area.

Figure 4: Main screen of Elli3.COM


Source: Baladincz et al. 2013

In the table 1 you can find the meaning of the buttons which are in the main screen.

Table 1: Functions of the main screen

| | |
|---|---|
| TRAVEL | Travel time between the positions |
| SEARCH | Identification of picking position and collecting products ID. |
| PICK | Picking the products to the pallet |
| ADMIN | The time needed for administrative task for the picking person |
| OTHER | Special occurrence |
| SETUP | Pallet settlement, Palletisation problem |

### 4.1. Elli3.com case study

#### *4.1.1. General functions*

PLAY-PAUSE-STOP

- Always start the measurement by pressing the Play button
- With press the play button the picking list extracting time will be recorded
- It is appropriate to use, if the measuring person make an mistake during date capture ( for example he forget to push the picking button, he made an error he pushed the wrong button, ect.)
- When you touch the pause button the Csv files will stopped automatically and when you will touch the play button new Csv file will start. (file name will be quite the same just the new file name will get an "-2" number on the end.

- To stop the measurement process you have to press the Stop button
- The related operations Csv and Barcode Csv files are prepared and closed

RECORD

- Voice record function
- During the picking is something irregular happening , the assessor person has to push the record button to record the voice, and he have to tell everything about the irregular event because it is important in the evaluation.
- To stopped the record you have to touch one more time the record button
- The files are saved with time stamp into the measuring device memory, so the valuation of the picking task can assigned clearly

Identification of the elementary picking process

TRAVEL

- Travel, transportation time spent between the picking positions - Pressing the button once to start operation, travel shows, any other operation button will automatically mean the end of the operation, Travel
- The start of the operation when the machine start to the picking area to halt until the target position
- SEARCH
- Usually is recorded after the Travel button, but it may happen that with one stop the picking person can pick two or more items so doesn't have to move the jet because the picking positions its really near each other.
- The search operation start with the identification of picking position and ends with the collecting products ID.

PICK

- Normally, the Search process begins with the completion of the last pallet put into picking product lasts
- When the picking warehouse colleague has a space and staff product knowledge thanks to the Search operation is very short (less than or completely), it may, after the operation Travel - Search for skipping - Pick will be recorded
- The picking of the tablets recording the position data via Bluetooth barcode reader attached to Pick validation process takes place after that.

ADMIN

- The time needed for administrative task for the picking person
- Administrative task can be indication of the performance of the picking list or includes the study of the pick list to select the next picking position
- The admin process is start when picking person pick up a pen and finish when put down for his hands the pen and the picking list
- Equally important to record the time needed for administrative tasks - these tasks can be marked in the performance of the picking list or pick list includes the study of the next picking position to select

OTHER

- Here are recorded the previous operations not falling within the scope of activities, such as the inclusion of pallets or pallet placement of the manipulation of the collected background

SETUP

- The time what you spent with the palletisation and rearrange stack.

### 4.2. Data Processing

The Elli3 software records the time-stamped data to the dedicated folders on the tablets by three forms:

- start and duration of the operations edited by the screen (travel, search, pick, admin, setup, other, in 'csv' extension)
- the involved storage IDs during the picking is sent by barcode readers via bluetooth connection (in 'csv' extension)
- specific additional information - needed for later evaluation ( in '3gp' format)

The evaluation is based on the several measurement day with different occupation.

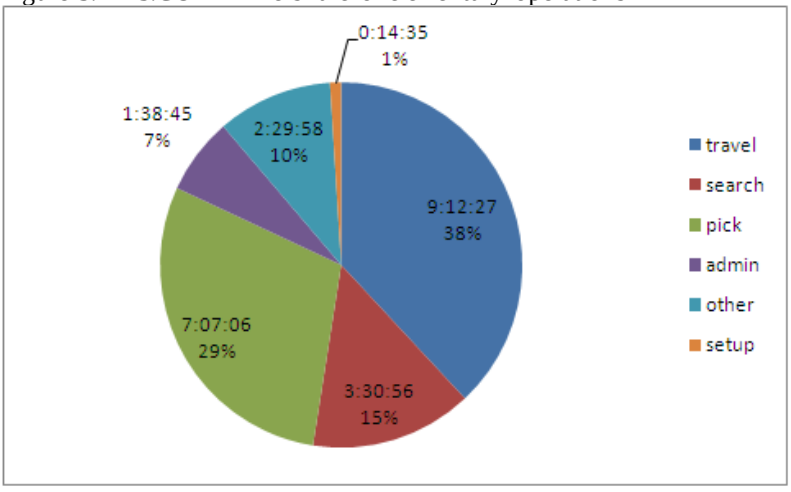
### 4.3. Sorting the input data

- The created files (picking list) by Elli3.COM application (processes and positions codes) are copied to a worksheet
- We filter the picking operations in a separate column and colligate with the appropriate storage IDs from the list registered by the barcode readers (in case of divergence we clarify with the help of voice files and printed picking lists)
- We assign the paper based invoice codes with the appropriate worksheet
- We transform the received data tables for further processing (clustering and processing input data)

### 4.4. Comparison of the proportions of picking operations

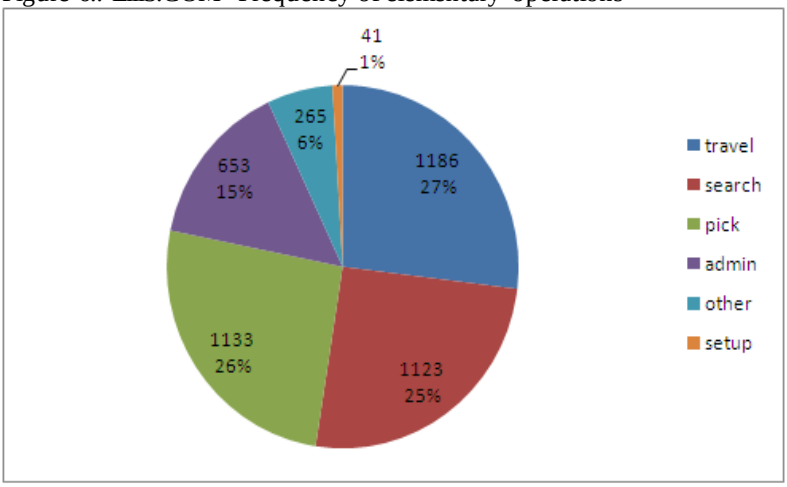
- sum up the time spent on each elementary operations, and the occurrence of operations, sort by the picking lists into a tables
- The following graphs are created as a sample:
- The left graph shows the time-consumption, the right shows the frequency of elementary operations.

Figure 5: Elli3.COM Time-share of elementary operations




Source: Baladincz et al. 2013

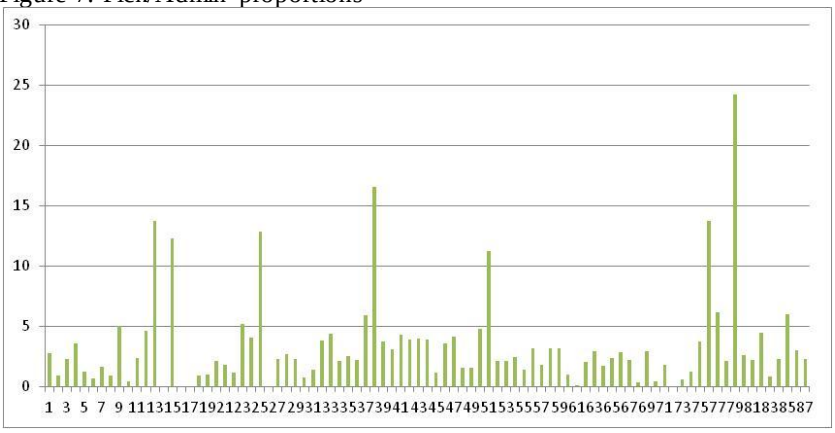
Figure 6.: Elli3.COM Frequency of elementary operations




Source: Baladincz et al. 2013

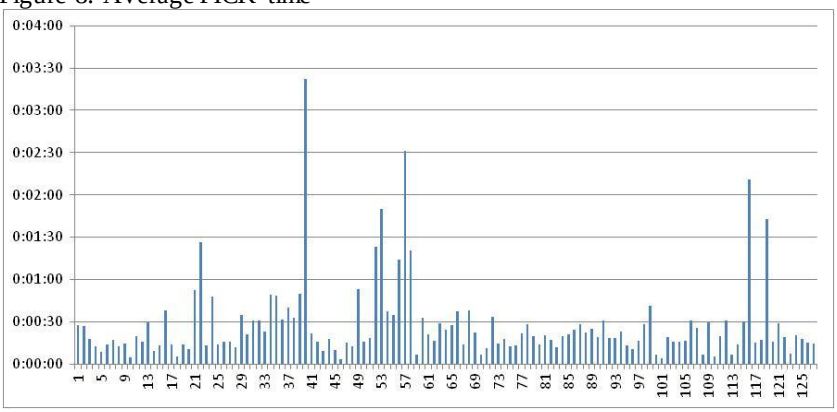
The proportion of PICK/SEARCH, SEARCH/PICK, PICK/ADMIN and ADMIN/PICK operations are demonstrated on the bar graphs below.

Figure 7: Pick/Admin proportions




Source: own study

Figure 8: Average PICK time



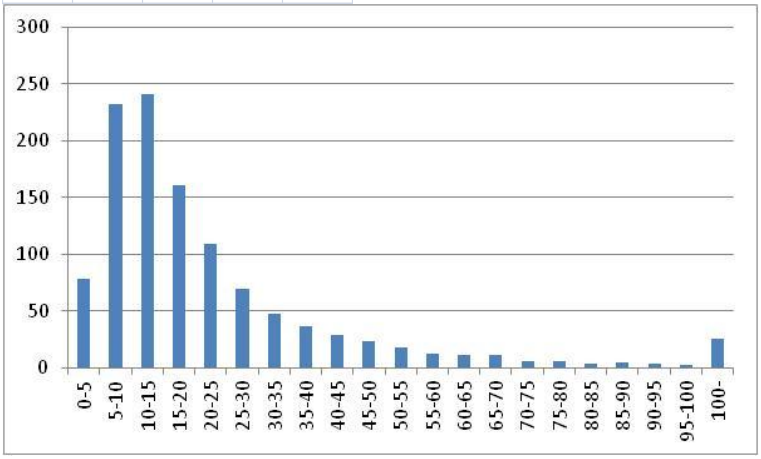

Source: own study

**4.5. Partition**

- We arrange the duration of operations in a summary worksheet
- We sum up the occurrence of each operations
- The next sample graphs show the allocations of particular operations
- For the better understanding we transform the tablets into the appropriate scales
- For example the green cell shows the PICK operation with the duration between 5-10 seconds has been registered 230 times

Figure 9: Allocation of time-consumption in Pick operations

| | pick | 0 | 5 | 10 |
|---|---|---|---|---|
| | 5 | 0-5 | 5-10 | 10-15 |
| | | 0 | 0 | 0 |
| | | 0 | 0 | 0 |
| | | 0 | 0 | 0 |
| | | 0 | 0 | 0 |
| | | 0 | 0 | 0 |
| | | 0 | 0 | 1 |

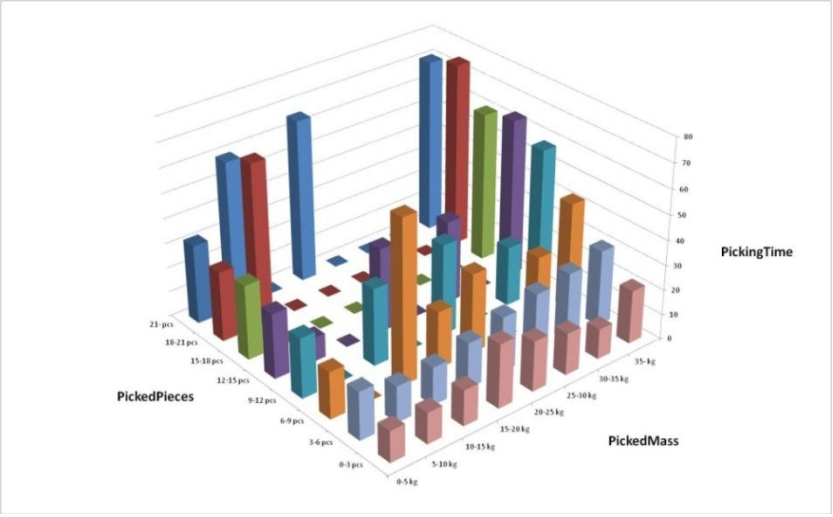



Source: Baladincz et al. 2013

### 4.6. Forming typical operation clusters

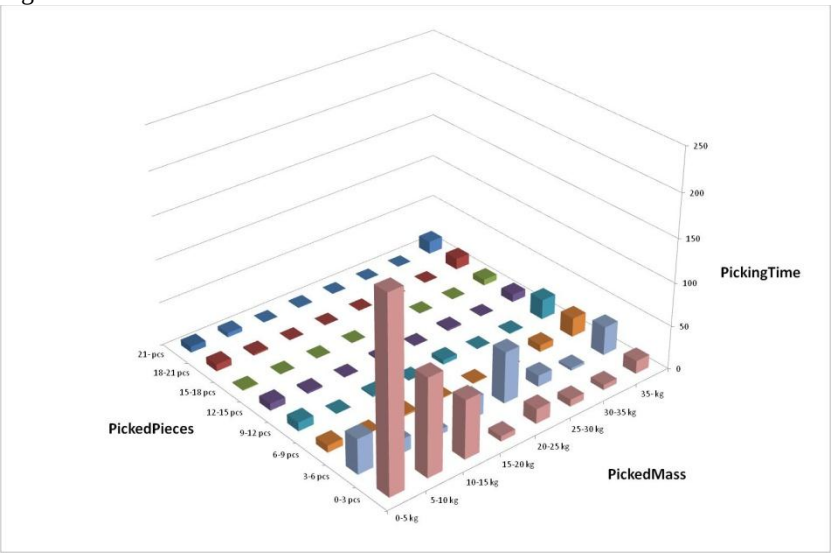
- We form the clusters based on the quantity and weights for analyze the picking specification
- We integrate the different weights and the palletisation properties into the list of item numbers (the database we received from the partner)
- Sum up the total moved mass in kilograms by picking tasks
- We perform the clustering with the method described in the previous paragraph considering the number of items and the mass
- Using the database functions we create statistical indicators according to the clusters (mean, median, mode, range, standard deviation, variation)
- From the obtained value we form a 3D graph:

Figure 10: Average picking time value by the recorded clusters regarding to the collected quantity and total weight




Source: Baladincz et al. 2013.

Figure 11: Amount of measured data in clusters




Source: Baladincz et al. 2013.

## 5. CONCLUSION

In this paper we presented the Elli3 application, which is good for measuring order picking processes in a warehouse. We showed a case study about a measurement made at a warehousing company in Hungary.

After the measurement we could see the time request of the elementary order picking operations and the time consumption of the operators among others. We evaluated the average picking time of the clusters we made from the collected data.

In the future we will extend the Elli3 monitoring applications in manufacturing and further logistics processes.

## 6. ACKNOWLEDGEMENT

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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# BUILDING e-CLUSTERS

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***Abstract***

E-clusters are strategic alliance in TIMES technology sector (Telecommunication, Information technology, Multimedia, Entertainment, Security) where products and processes are digitalized. They enable horizontal and vertical integration of small and medium companies and establish new added value e-chains. E-clusters also build supply chains based on cooperation relationship, innovation, organizational knowledge and compliance of intellectual properties. As an innovative approach for economic policy and new e-business strategy e-clustering has very important role for old clusters renovation and growth in region affected by economic crisis and other adversities. This paper analyzes building of horizontal and vertical e-clusters. Results of this analysis can be used for transformation of old clusters, innovation of cluster's products, processes and added value chains.

The structure analysis of horizontal e-clusters oriented to suppliers or customers, and horizontal Marshallian e-clusters explain how those can enter in large e-supply chains. Various organization forms, topology of cooperation and innovative process in vertical e-clusters are analysed and focussed on e-logistic systemstructure and development.

**Keywords:** e-cluster, cooperation, e-supply chains, e-logistic

## 1. INTRODUCTION

Small and medium enterprises (SME) from TIMES technology sector, universities and research institutes, customers, government and other stakeholders established **TIMES clusters** or **e-clusters** which enclose processes of cooperation, innovation and process oriented knowledge management. E-clusters have infrastructure which accelerate knowledge distribution, reduce transaction costs, stimulate competition and cooperation, enforce specialization and internationalization of the economic and cluster-specific relations etc. (Hansen, 2004). **E-clustering** is a macroeconomic concept of building clusters in TIMES technologies sectors that support a wide concentration of rivals, customers and suppliers as well as their focus on specialization, efficiency and innovation, digitalization of the internal cluster processes and processes between clusters (Hansen, 2005). It is an innovative approach for economic policy and new e-business strategy for older clusters based on continuous improvement of value-added chain and product innovations that result in speeding growth of clusters and region (Bangura, 2009).

E-cluster is defined as information network that integrates industry, universities and research institutes. Its functions are support for company promotion and marketing, business administration, cluster management, information management on industrial

complexes and neighbouring regions, as well as for management of database of industries, universities and research institutes[11].

E-clusters are based on factor and demand conditions, related and supporting industries, structures of companies and rivalry which M. E. Porter arranged in a diamond-shaped diagram. This paper will focus on cluster structures and suggests definition of e-clusters as a business network that horizontally or vertically integrate companies in TIMES sector. In this way e-clusters build procurement and distribution of e-channels and e-supply chains, provide product and processes innovation and apply knowledge and other local strengths for growth of productivity and attainment global competitive advantage (Davidović, 2013). This definition also implies generic horizontal and vertical e-clusters, and logistics of e-cluster definitions (see Chapter 2).

Chapters 3 and 4 will analyse how to build horizontal and vertical e-clusters and their e-logistics, as well as how to transform horizontal to vertical e-cluster (see Chapter 4). This e-cluster structure analysis implicates basic models and characteristics of cooperation processes and their impact on e-cluster logistics.

There is a difference between the terms "e-clustering" and "building e-clusters": e-clustering is a macroeconomic concept and strategy, while building e-cluster is a formation of cluster's organization.

## 2. e-CLUSTERS AND e-CLUSTERING

**E-cluster** is a geographic concentration of interconnected TIMES companies, specialized suppliers, service providers, companies in related industries, and associated institutions (universities, research institutes, standards agencies and trade associations) in a particular field that compete but also co-operate (Hansen, 2004; Porter, 1998).

E-clusters can be classified into horizontal and vertical. **Horizontal e-clusters** share common factors: same TIMES technology, digitalized working processes, skills and other organizational knowledge, market for end digital products and same suppliers or customers. Horizontal e-cluster is usually a group of TIMES SMEs that work the same level of a value chain. Between members of a cluster there is no digital products flow (no interchange); while the cooperation is oriented only to common performance in the market (see Chapter 3).

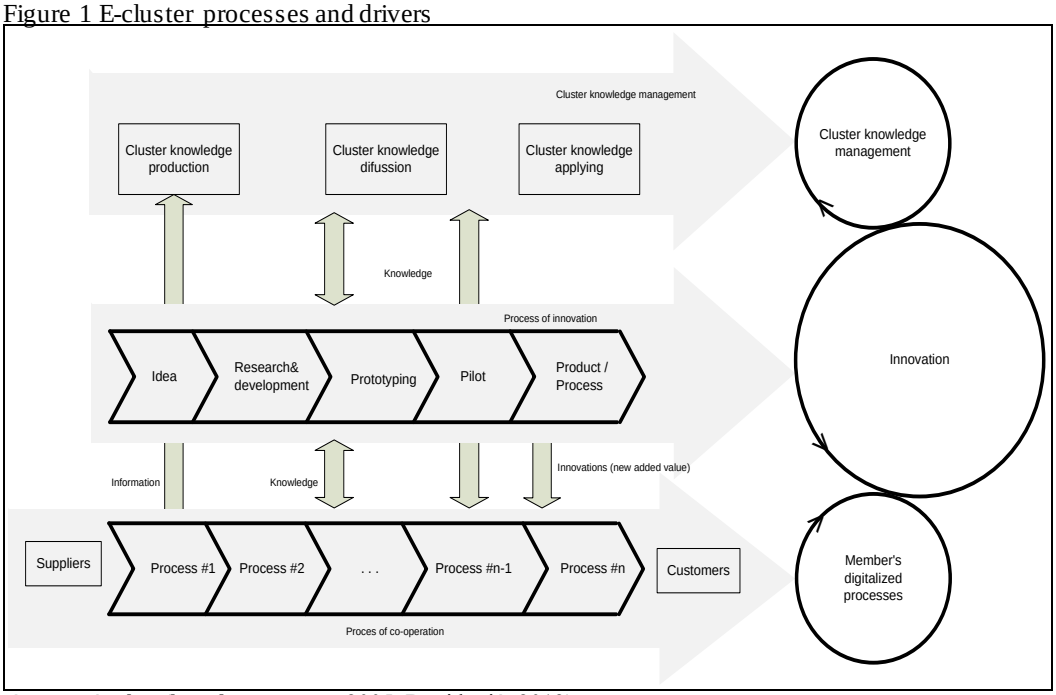
**Vertical e-clusters** consist of members and partners linked through buyer-seller relationship supported by e-business system. All members and partners enter in cluster e-value chain and participate in the realization of common end products or cooperative projects. Vertical e-clusters set up a common value e-chain, e-procurement and e-distribution channels or chains, and supply e-chain with a new added value. Structure of vertical e-cluster is determined by a topology of cooperation process (see Chapter 4).

E-clusters as regional clusters have the ability to offer knowledge, relationship and motivation which can't be matched by their distant rivals (Porter, 1998). Building e-clusters include fostering their local strengths and a collaborative environment organization where job and innovative digital products creation and new entrepreneurial innovations are able to flourish and can reap the tangible returns (Porter, 1998). E-clusters therefore need an organization of three mutually dependent digitalized processes: cooperation, innovation of

[11] The Industrial Complex Cluster Program of Korea, Ministry of knowledge economy of Korea and KICOX – Korea Industrial Complex Corporation Cluster, November, 2010 [available at www.kicox.kr or www.e-cluster.net]

digital products and processes, and cluster knowledge management. Innovations and knowledge are the main drivers of e-clusters competitiveness and growth (see Fig 1).

Figure 1 E-cluster processes and drivers




Source: Author (based on Hansen, 2005; Davidović, 2013)

**Process of innovation** enables improvement of digital products and digitalized cooperation processes through the following phases:

- idea,
- research and development,
- prototyping,
- pilot construction,
- implementing the innovation (digital product or digitalized process);

Results of innovation increase cluster productivity and originate spiral growth of cluster knowledge.

**Organizational knowledge management** includes next phases:

- creating or production,
- diffusion or distribution and
- applying;

E-clusters can organize knowledge management either as a function of cluster management or as cooperative projects (Davidović, 2012).

The universities, research institutes and consulting organizations participate in processes of innovation, creating and diffusion of organizational knowledge.

The process of cooperation in horizontal e-clusters is very simple, as it is oriented only towards common performance of cluster in domestic and international market. Horizontal e-clusters can use suppliers and customers e-services or set up own procurement and sales

e-channels (see Chapter 3). The cooperation in vertical e-clusters is structured as a project, production, end product's structure or relationships between cluster members (see Chapter 4).

**E –logistics** consists of processes necessary to transfer the goods sold over the internet to the customers. It provides "supply chain integration that can eliminate intermediaries such as wholesaler or retailers and fosters the emergence of new players like logisticians, whose role is to adapt traditional logistics chains to take into account the requirements of e-business" (Groznik & Kovačić, 2004). E-clusters integrate the e-logistic in process of cooperation, since digital products transfer is directed from external/internal seller to internal/external buyer (seller's up-load to buyer or down-load on demand of buyer).

**An e-cluster e-business system** is e-logistics subsystem that supports (Davidović, 2013):

- a safety interchange of intangible products, e-services, money and information,
- a cooperation of relationships based on business processes restructuring and improvement,
- standardized electronic transactions in interchange between members and partners,
- a realization of cluster's cooperative projects and digital products, and
- a performance of cluster in the domestic and international market.

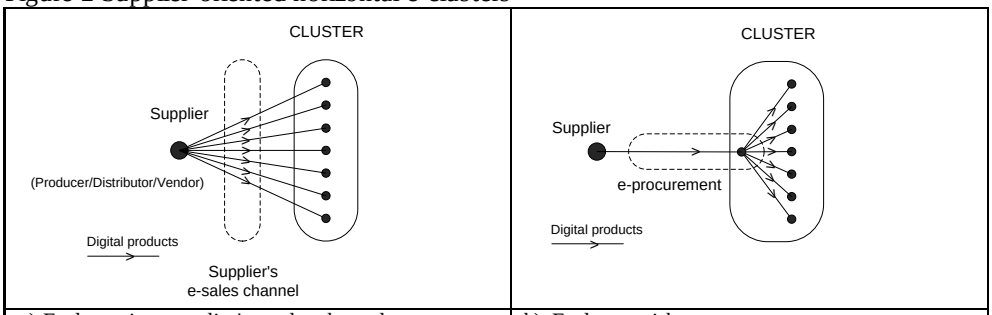
**E-clustering** is a part of macroeconomic politics and strategy that fosters the networking of TIMES companies and other participants in new value-added chains. The objective is to bundle the potentials and competences in e-clusters as a driving force and an accelerator for the economic and technological development of a region (Hansen, 2004). Building e-clusters is a key activity in the e-clustering policy or strategy implementation, because wrong model can prejudice relationships between cluster members or raise investment, and therefore slowdown the growth of e-cluster. Following analysis showcases a potential organization of horizontal and vertical clusters, transformation from a horizontal to a vertical e-cluster, and various combinations of topologies that get more effective performance of clusters in the global market.

## 3. BUILDING HORIZONTAL e-CLUSTER

### 3.1. Supplier oriented horizontal e-clusters

If members of horizontal e-cluster are supplier oriented then e-cluster either enters in supplier's e-sales channel or links with a supplier over own e-procurement (see Fig. 2a and 2b).

Figure 2 Supplier oriented horizontal e-clusters




| a) E-cluster in a supplier's e-sales channel | b) E-cluster with an e-procurement |
|---|---|

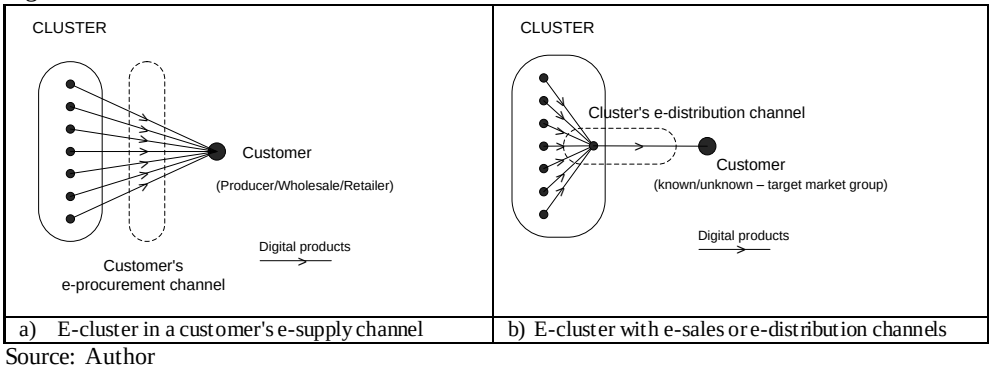
Source: Author

A supplier is any producer, distributor or other vendor of digital products. Products flow from a supplier to members of e-cluster. Every member adds a new value and can compete to others. E-procurement is an e-service of a member, partner or a cluster management.

### 3.2. Customer oriented horizontal e-clusters

When members of horizontal e-clusters are customer oriented then e-cluster enters in a customer's e-supply chain or builds an own e-distribution channel (see Fig. 3a and 3b).

Figure 3 Customer oriented horizontal e-clusters




| a) E-cluster in a customer's e-supply channel | b) E-cluster with e-sales or e-distribution channels |
|---|---|

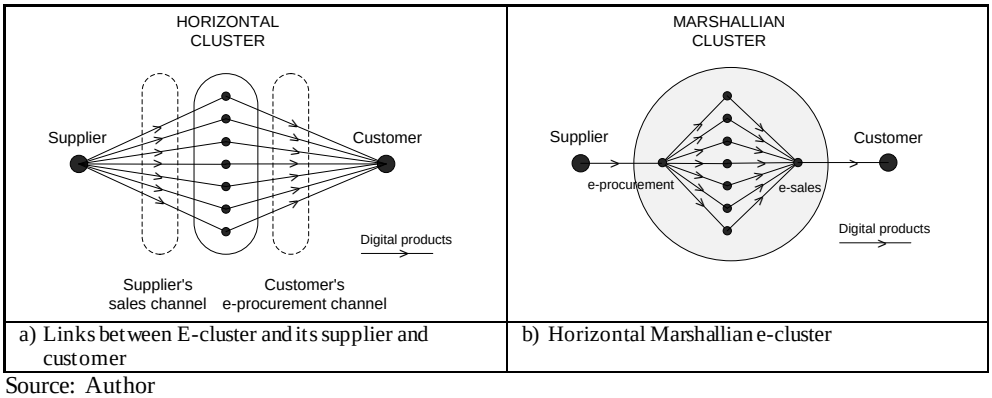
Source: Author

Customer is a producer, a distributor, a wholesaler or a retailer of digital products. E-sale is a service of member, partner or cluster management. If cluster has adequate e-distribution channel (for example, Web shop) then any member of a cluster can deliver their digital products to unknown consumers directly or over fully automated cluster's e-sales function. Every member can compete to others in common using cluster's e-distribution channels and another market sectors.

### 3.3. Marshallian e-clusters

Interconnections between horizontal e-cluster, a larger supplier and a customer shown in Fig. 4a are theoretically possible, but taken risks maybe unacceptable for customer, supplier or cluster. The structure known as Marshallian cluster[12] is a better solution (see Fig. 4b), because it provides integration in supply chains created by other producers and larger buyers of digital products.

Figure 4 Integration of horizontal e-clusters in other supply chain and Marshallian horizontal e-cluster




a) Links between E-cluster and its supplier and customer

b) Horizontal Marshallian e-cluster

Source: Author

Basic structure of horizontal Marshallian e-cluster is a result of integration topologies in Fig. 2b and 3b. Members provide services in a producer's supply chain such as development, sales, maintenance, help desk or education. For example, a cluster of small software companies uses provider's software and every member has all intellectual property rights needed for new software products development and their distribution to a known customer.

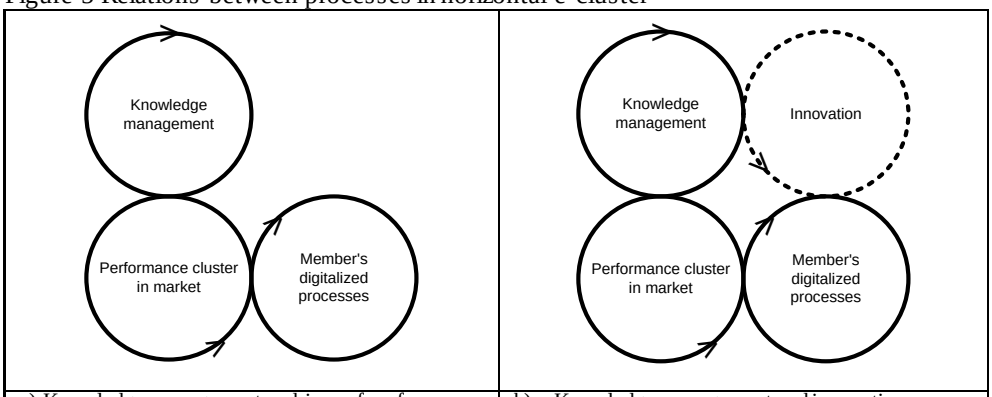
### 3.4. Performance of e-clusters in the market

A group of SMEs from TIMES technology sectors is a horizontal e-cluster when it has e-procurement and/or e-distribution channels. Through horizontal cluster, members can jointly enter markets and thus exploit human and other resources with greater efficiency (see Fig 5a).

Cluster knowledge management supports acquisition, diffusion and applies new organizational knowledge (know-what, know-why, know-how, know-who, know-where and know-when) and so improves the cluster performance in market. Knowledge management can organize as process, task or cooperative project (Davidović, 2012). However, sustain development of horizontal e-cluster necessitates the innovation of members' digitalized processes, services and products (see Fig 5b).

[12] This cluster model has equivalent topology as Marshallian industrial district; Alfred Marshall (1842-1924)

Figure 5 Relations between processes in horizontal e-cluster




a) Knowledge management as driver of performance cluster in market

b) Knowledge management and innovations as drivers of sustain development and growth of e-cluster

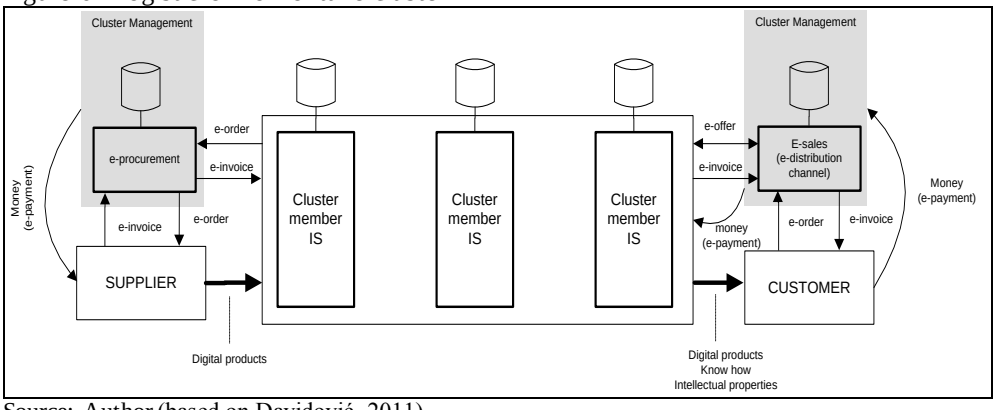
Source: Author

Horizontal e-cluster needs a good relationship with universities, research institutes, consulting companies and creative people. This is a way for new value-added chains building and transforming horizontal e-clusters in more efficient vertical e-clusters (see Chapter 4).

### 3.5. E-logistics of horizontal e-clusters

E-procurement and e-sales are parts of e-logistics in horizontal e-clusters. E-procurement collects and combines members' e-orders in one cluster e-order to a supplier. E-payment can do a cluster member direct to a supplier or across the cluster account (see Fig 6).

Figure 6 E-logistic of horizontal e-cluster




Source: Author (based on Davidović, 2011)

Horizontal e-cluster can organize e-sales over indirect distribution e-channels (Fig. 3a) or direct distribution e-channels (Fig. 3b). Indirect distribution e-channels are producers and

customers supply chains or e-portals. Direct distribution e-channels are marketing e-channels, Web shops and e-portals (Davidović, 2011).

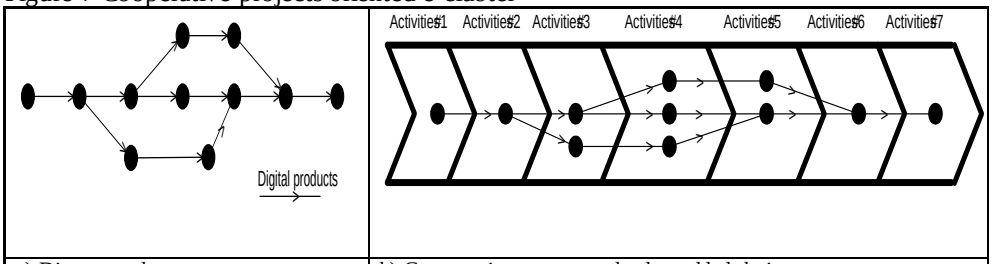
E-logistics of horizontal e-cluster is an e-business system. Basic application framework of e-procurement and e-sales are e-order, e-offer, e-invoice and e-payment. If the cluster does business with know-how and intellectual properties then e-contract need include. Digital products up-load and down-load are function of e-sales.

## 4. BUILDING VERTICAL e-CLUSTER

### 4.1. Cooperative projects oriented e-clusters

Structure of **cooperative projects oriented e-clusters** is described with a directed graph in Fig. 7a.

Figure 7 Cooperative projects oriented e-cluster




a) Direct graph | b) Cooperation process and value-added chain

Source: Author

The nodes determine project activities. Directed branches are correspondent the interrelations between members in project realization. Each cluster member or partner can realize one or more activities which add a new value. Directed graph can include activities of innovation process, procurement, product realization, delivery of the product to the customer and post-sales e-services. Cooperative project can be one time or regularly recurring by orders of customers. Members and partners realize project activities and sub-processes that build value-added chain as in Fig. 7b.

### 4.2. Topology of e-clusters oriented to common end product

**E-clusters oriented on common product** can have four types of topology:

- Linear chain (see Fig. 8)
- Star (see Fig. 10 and 11)
- Tree (Hierarchical organization, see Fig. 12)
- Network (see Fig. 9b).

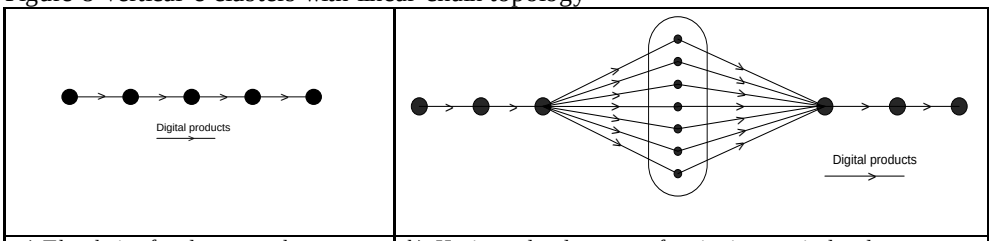
Network is a generic topology, while chain, star and hierarchical organization are their special cases: a linear chain is correspondent to a path, while a star and hierarchical organization correspond to a tree in the network. The cluster topology depends of technology, product structure, and relationships in the cluster.

### 4.3. Cooperation process as linear chain

When e-cluster builds the chain of activities, or sub-processes and value-added chain as in Fig. 8a, then every member of the chain is an internal seller and buyer, except of the first and the last. The first member is an external partner (supplier) or a cluster member as an internal seller, while the last member in the chain is an internal buyer that delivers products to customer or known external buyer. Every member can organize their own procurement or uses e-procurement services of a cluster organized as in Fig. 2b.

Horizontal e-cluster can transform to vertical e-cluster when buildings its own supply chain with new members and partners such as in Fig. 8b. This model is also typical for e-clusters that gather SMEs due to necessary capacity of production or assortment of products and services.

Figure 8 Vertical e-clusters with linear chain topology

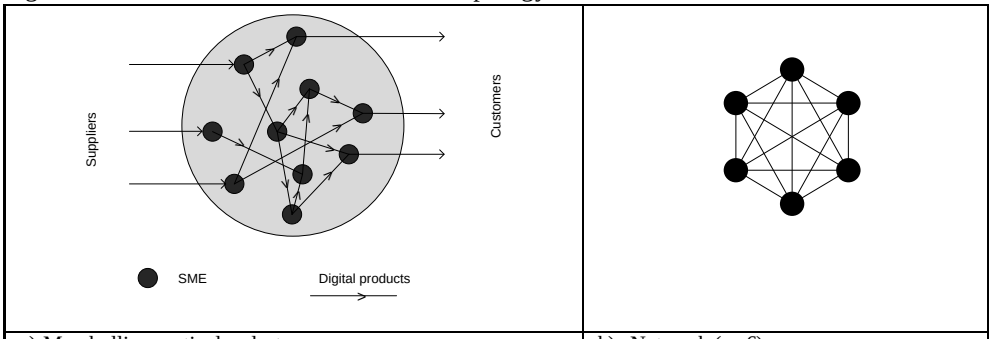



a) The chain of e-cluster members | b) Horizontal e-cluster transforming in a vertical e-cluster

Source: Author

In vertical Marshallian e-cluster (see Fig. 9a) exists links between members and partners which result with new added values for customers. This topology is derived from horizontal e-cluster topology (see Fig. 4b) and building linear chain between several members and external partners as in Fig. 8a. Marshallian clusters can derive from network, too (see Fig. 9b). In Marshallian clusters there is no dominant member.

Figure 9 Vertical e-clusters with network topology




a) Marshallian vertical e-cluster | b) Network (n=6)

Source: Author

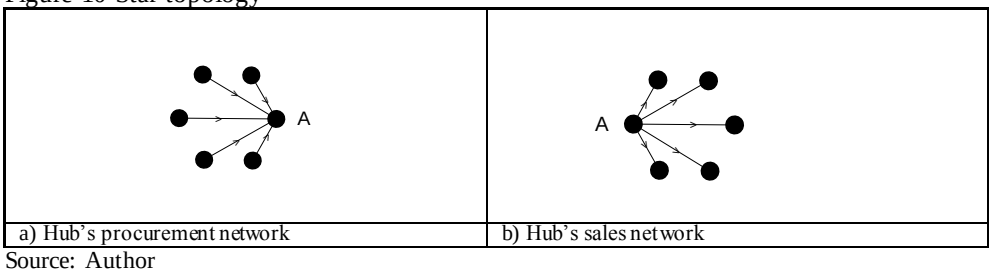
### 4.5. Network topology

Network topology (Fig. 9b) is appropriate for complex creation of creative products, process of innovation and knowledge management processes. Links between members of network are directional or bidirectional. Cluster management system and e-logistics are more complex in large networks and multiply relationships between members, hence building vertical e-cluster should be based on business cases which need e-logistics with simple topology. The network of a cluster can be divided in the simplest topologies that correspond to business cases based on end digital products (in multiproduct clusters), cooperation processes or tasks (linear chain, star, hierarchical structures), cooperative projects (in cluster oriented to projects) or their combinations.

### 4.6. Vertical e-cluster models based on star topology

Organization models of clusters have star topology (see Fig. 10a and 11b). Node A is a hub or a centre that corresponds to dominant members in hub-and-spoke clusters, satellite platform cluster and state centred cluster models.[13] Other nodes correspond to the members – internal sellers (Fig. 10a) or the internal buyers (Fig. 10b). Direction of branch shows the flow of products; in Fig. 9a it performs input of A, in Fig. 10a output of A. Networks on Fig. 9a and 9b correspond to procurement and sales network or channels.

Figure 10 Star topology



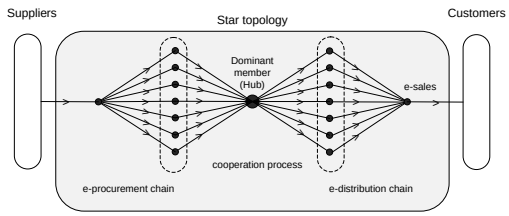

a) Hub's procurement network | b) Hub's sales network

Source: Author

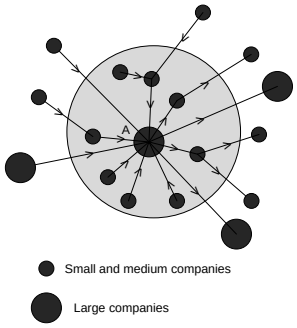
Basic structure of **hub-and-spoke cluster** is a combination of star topologies from Fig. 10a and 10b (see Fig. 11a). A member in the real structures can link with dominant member A over linear chain (see Fig. 11b). In this model every dominant member has its own e-procurement and e-sales network, post-sales e-services etc. The hub-and spoke e-clusters have two or more star topologies, relating to number of dominant members (leaders) in cluster. Hub links each other hubs; no direct linkage between other members (SMEs) to other stars exists.

[13] These terms take from Boja [10]

Figure 11 Hub-and-spoke vertical e-clusters




a) Basic model




b) Real model

Source: Author

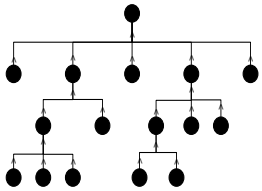
**The state centred cluster model** has topology shown in Fig. 11a (this model has only one hub). **The satellite platform cluster model** has two or more separate and independent star topologies that set up branch offices of multinational companies (Davidović, 2013; Boja, 2011).

### 4.7. Hierarchical organization of e-clusters

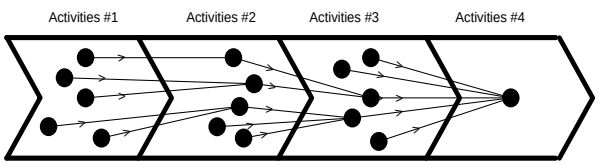
Cooperation process in vertical e-clusters can organize hierarchy equivalent to end product structure or content (see Fig. 12a). Value added chain for this case is shown in Fig. 12b. One member can realize more activities on different stages of e-supply chain.

Hierarchy structured vertical e-cluster can be build from horizontal e-clusters when those specialize in production parts of digital end-products.

Figure 12 Hierarchic structured e-clusters



a) Direct graph



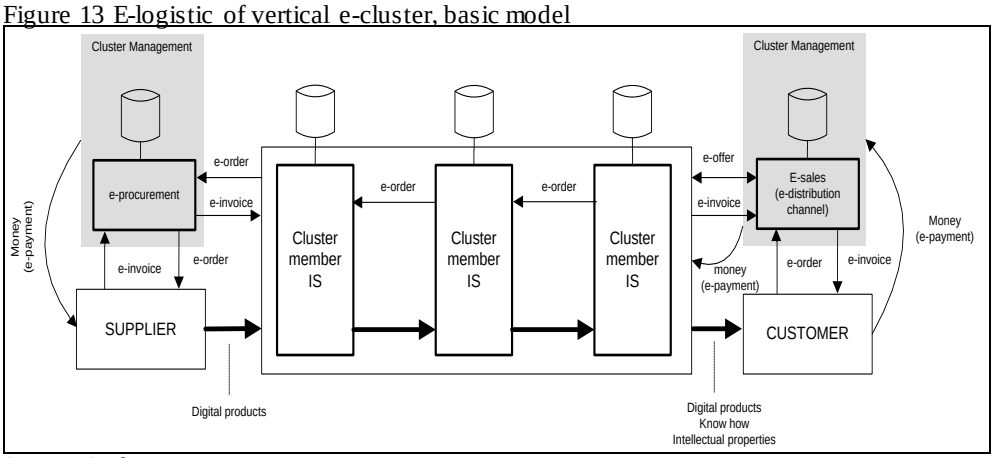

b) Cooperation process and value-added chain

Source: Author

### 4.8. Building e-logistics in vertical e-clusters

E-logistics in vertical e-cluster is an e-business system that supports procurement, cooperation and distribution processes (see Fig. 13).

Figure 13 E-logistic of vertical e-cluster, basic model




Source: Author

The project oriented e- clusters can use project management system and internet for digital products transfer. The product oriented e-clusters can implement supply chain management system or intellectual property management system for other intangible assets. These e-business systems can support cluster cooperation and innovation processes, and the performance of cluster in domestic and international markets. E-clusters with e-knowledge management are more competitive because knowledge and innovation are the key drivers of cooperation development (see Fig. 1 and 5b).

## 5. CONCLUSION

Building e-clusters is the first phase of implementation of e-clustering as macroeconomic politics or strategy. The choice of e-cluster organization structure determines its future market position and further development.

The development of horizontal clusters is oriented to building adequate e-logistics and positioning in a large supply e-chain which allows its building extension based on innovations and new value-added chain organization (linear chain, vertical Marshallian e-cluster). The attachment of one geographic concentration of SMEs TIMES companies with a dominant large TIMES company, multinational company branch office, state or public company results as a hub-and-spoke, satellite platform cluster or centred state cluster, respectively.

Project and common product oriented e-clusters develop structure equivalent with project or digital end-product structure, and innovate or renovate it according to customers' needs.

E-clusters develop e-logistic that is integrated in the cooperation process and includes an e-business system, process oriented cluster organizational knowledge management and innovation management. Universities and research institutes support sustain of e-cluster development based on new TIMES technologies or digitalized cooperation processes, digital products and e-services innovations.

This analysis can apply in old TIMES cluster renovation, too.

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# SYNCHRONIZATION OF PLOTTING BOARD AND COMPUTER BASED SIMULATION IN THE FRAME OF LOGISTICS PROCESS REENGINEERING

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***Abstract***

The warehousing processes contain many hidden opportunities for cost-effective process development. Cost and performance optimization is possible with reengineering of algorithms, assignment decisions, scheduling and sequencing solutions without infrastructural investments. The only objective and cost-effective way of development is modelling in validated and flexible simulation environments in active cooperation with the partner. In our essay, we introduce our innovative modelling and reengineering methods and environments continuously developed in Szabo-Szoba R&D Laboratory at Széchenyi University Győr. Our LPR solution combines the advantages of the performance measurement, plotting board, the computer simulation, by considering the feedback

**Keywords:** simulation, logistics process reengineering, innovation

## 1. INTRODUCTION - IMPORTANCE OF MODELLING

The main challenges of modern logistics and supply chain management are providing high level quality service for customers according to the ever-growing and ever-changing

demands, optimizing low series production and distribution in various environments, managing stocks in lean and agile production systems, eliminating the bullwhip effect, applying different trade-off solutions for minimizing infrastructure investment, distribution and warehousing costs and maximizing capacity utilization. The wide variety of products, the challenges of fluctuating demand, the appropriate inventory management and the application of modern production and distribution strategies require flexible innovative thinking and special management skills from experts: to be able to construct and manage an effective, well-balanced manufacturing and distribution process in supply networks.

The learning-by-doing method, based on personal experience (dialectic approach) is able to help in the education and training to get these innovative and cooperative skills. The main purpose of our learning-by-doing simulation projects in Szabó-Szoba R&D Laboratory is to construct special real-life environments for training on the field of logistics: modelling the product and information flow in a supply chain, taking care of shipments, material handling and order picking processes of a warehouse or a factory (Bancsó et al. 2013).

In these creative environments all the actions are provided by participants – focusing on the evaluation of the results and the whole process of logistics performance measurement. During the learning-by-doing trainings participants can get practical knowledge and develop many innovative skills to be able to construct, observe, design and re-engineer sustainable and efficient logistics processes (Bancsó et al. 2013).

Modelling has key role in logistics system design and further development. Based on models and simulations it is easier and cheaper to discover problems and bottle necks of logistics processes. Furthermore these are the only objective methods for finding optimal and adaptive solutions, or test the available alternatives (Bódis at al. 2012).

The most known modelling method in daily practice is the computer simulation. The WaNDa warehouse and distribution plotting boards and simulation equipments are unique and can provide innovative approach for participants, to get real-life experiences about warehouse activities on the learning-by-doing way (Bódis at el. 2012).

Both the plotting board and the computer simulation based modelling solutions have unique advantages and disadvantages. The our simulation equipment synchronizes the two modelling solution, what makes the user possible to model warehousing systems and problems, collect alternative solutions, measure and evaluate the performances and demonstrate for the partners on visible and understandable way.

The measurements are also important and essential equipment during WaNDa training simulations. It gives the possibility to evaluate the defined and tested alternatives.

## 2. PLOTTING BOARD AND COMPUTER BASED MODELLING

The plotting board modelling methodology is constructed for simplified processes and layouts based on real systems, algorithms and database. This instructive environment support the brainstorming methods, helps to the participants generate various ideas and alternatives (Bódis et al., 2012).

The physical nature of plotting boards gives huge advantages. It is possible to compare different layouts, rack settings, palletizing problems, capacity utilization, routing, storing and order picking algorithms. So the participants can perform immediately huge amount of alternatives by hands without time-consuming programming requirements. On the other

hand, the real efficiency of complex processes is measurable after huge amount of operations. It is very time consuming, so impossible to perform in frame of trainings.

The computer simulations make us able to model complex logistics systems based on mathematical, statistical methods and algorithms. Parametric structure and refreshable database help to synchronize the model with the actual situation for each project. The system can continuously collect statistics and generate charts in real-time, which data mean the basis of the comparisons of alternatives (Bódis et al. 2012).

In our essay we introduce our innovation cycle that synchronise the plotting board and computer based simulation solutions.

## 3. THE WaNDa PLOTTING BOARD MODEL

WaNDa (Warehouse aNd Distribution) is an extremely interesting and representative model for logistics students and training participants to learn and understand relations and coherencies in supply networks and warehouses. It has also importance in industrial application. Operational efficiency of the companies is strongly affected by the design decisions, but it can be very expensive or impossible to change the design decisions once the warehouse is actually built. WaNDa environments are able to demonstrate all the impact of these decisions on the overall warehouse performance (Bódis et al. 2012).

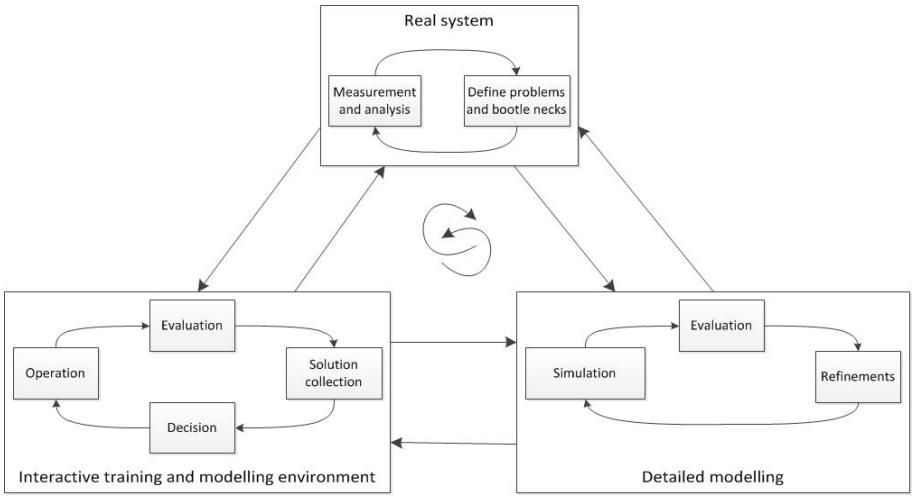
The WaNDa interactive equipment is usable for the following functions:

- Educational trainings for demonstrate warehousing problems, tradeoffs and search possible solutions with the help of learning-by-doing
- Industrial and educational trainings for demonstrate importance of modelling and optimization.
- Interactive cooperation with industrial partners to get to know the processes and best practices of the actual system. The participants will realize the problems and bottlenecks of their own system. Furthermore they can decide the further cooperation in Logistics Process Reengineering projects and define the way of the innovation process.
- It is a valuable environment to support the brainstorming process. The consultants and partners can collect and immediately evaluate possible alternatives. In this way, they prepare previously evaluated alternatives for the detailed modelling.
- Demonstrate defined solutions for directors, managers and employees. The interactive way of demonstration result, they can believe more in the new processes.

## 4. INNOVATION CYCLE

The measurement and evaluation of the real warehouse is usually the first step of the innovation processes. The deep knowledge of the developed system is essential. It is required to the effective and usable results of the logistics re-engineering processes. Sometimes the measurements started after interactive training, where the importance of innovation is realized. The main aim of this previous training is to get to know the actual solutions, processes, best practices and problems together with the partners.

Figure 1 Consultancy cycle of innovation




Source: Vöröskői at al., 2013.

The interactive training and modelling environment has couple of function during innovation cycle, where the plotting board and the computer simulation are synchronised. This is the field of the active cooperation between consultants and partners.

During the detailed modelling processes the consultants make much deeper computer based simulations about the previously prepared and evaluated alternatives. These models are constructed with real scaled layouts and running with detailed programmed algorithms. These can test long time intervals and computationally intensive solutions. Furthermore it is possible to automatically generate all kind of statistics to compare alternatives.

The innovation and development projects are never a linear process. These require continuous feedbacks and round by round development. In my consultancy cycle, each element has two-way cooperation with each element. Each element has special added value for the processes. The final solution has to work in the simulation model, has to be visible and understandable in the interactive environment and has to be valuable and usable in the real system. The development and the fine-tuning processes are impossible without continuous round-by-round tests and feedbacks (Vöröskői et al. 2013).

The following chapters will describe the details of the consultancy cycle elements.

### 4.1. Real warehouse operation

The first step of each innovation process is the measurements of real physical processes and analysis of measured data and the possible operational databases. First of all, the consultant should get to know the partner's processes and logistics system. It happens during combinations of meetings, industrial visits and interactive trainings (Vöröskői et al. 2013).

Based on previous information, our Elli3 android based measurement tool will be customized to actual system. The innovation team defines the required measurements of the physical processes and the previous workflow of the measurement process.

Elli3 is an android based application developed in Szabó-Szoba Laboratory for monitoring the time request of all pre-defined operations with automatic time stamps. The examination of the workflow display-interface is adapted to the pre-defined actions appears to be measured - the assessor will tap to activate each key, and the device records the sequence of events with timestamps (Baladincz et al. 2013),

By using our Elli3 tool we can discover many hidden parameters of product and information flow. Based on the results and analysis we can classify the main features of the operations and the product structure.

Figure 2: Elli3 screen for monitoring order picking processes


Source: Baladincz at al. (2013)

The measuring team is still collecting information about the processes and refining the measurement system during the testing process of the adapted Elli3 system. The measurement can't influence the processes, the measurement colleagues have to build personal relation with the operators, so that they feel: it is not a test, we will help them. Equal treatment of the operators results valuable data and further exact information about the processes. In this way the innovation team will know what the operators really do, what are the best practices? The measured data and experiences continuously need work up between measurement events. It is a previous check of the data and essential to define how many further measurements need until the first analysis.

The first step of the analysis is to collect the latest documents of the real database to complete the measurement data. Based on data sources and personal experiences the innovation team define the possible bottlenecks and problems.

The measurement system will be upgraded for the defined problems to collect specified data and experiences. It results a measurement cycle what is going while the innovation team is getting strong knowledge and enough data for designing the partner's analogue model.

In the frame of the order picking development projects, the time requirements of picking movements (travel, search, picking, administration, so on) are measured. As a result we can show the time distribution of elementary processes and we are able to define the time-consuming operations. Furthermore the involved order picking positions are logged, what makes us able to analyse the possible time and distance savings in routing and product allocation. Otherwise the partners' database should also be analysed, concentrating on the

actual problem. After the necessary amount of measurement and analysis, the consultants have enough experience about the system for the modelling processes.

### 4.2. Interactive training and modelling environment

The next element of this innovative consultancy cycle is to collect and evaluate alternatives in simplified and synchronized interactive modelling environment (plotting board and computer simulation), what supports the brainstorming process. All possible solutions will be tested and evaluated in the analogue model. Only the valuable alternatives get option for the time-consuming detailed modelling, what results time saving in the innovation process.

The operation in the interactive environment starts with the analogue version of the actual processes of the partner. After the first operation round they will evaluate the process based on personal experiences and automatic measurement of the system. They will define the problems and start a brainstorming to collect solutions. Then a decision is made and the changes will be implemented into the model. The participants test the new solution and start again the innovation cycle of the interactive environment (Vöröskői et al. 2013).

The participants continue the alternative collection process while find 2-4 alternatives for detailed modelling.

### 4.3. Detailed modelling

During this step of the innovation process, the consultants build detailed computer based simulation model for each defined alternative with individual programming. This model is more complex, it based on the real scaled layout, real resource capacity, real amount of storage capacity and so on. Furthermore the computer based simulation makes us able to run the model in a long term interval. So the detailed modelling environment is good for seeing how the defined solutions will work in the real industrial system (Vöröskői et al. 2013).

The detailed simulation models makes it possible to refine alternatives, implement and evaluate new ideas, what result a new cycle in this level of the innovation process.

### 4.4. Global innovation process

Innovation is not a linear process, continuous feedbacks and round by round development are essential for valuable results. The 3 main element of the innovation process has continuous feedbacks with each other. The final solution has to be fit in both environments.

The defined alternatives are evaluated and refined in detailed simulation models. The find new solutions tested and evaluated in the interactive plotting board environment. This cycle is going while the partner and the consultants are not sure about the find solution is ready for the real operation.

After the implementation process, the upgraded real system will be measured again to check the efficiency and effects of the solution. Then the problems and the bottlenecks will be defined again and continue the consultancy cycle for continuous development of the system.

The continuously developed interactive environment is good for demonstrate system changes for operators, managers and directors also (who did not take part of the

development process). It results, that the colleagues will believe in the solution and support the implementation process (Vöröskői et al. 2013).

## 5. CONCLUSION

In our essay we have presented our innovation cycle, like a possible frame and tool to develop logistics processes.

The innovative consultancy methods support the continuous Logistics Process Reengineering projects in active cooperation with the partner. The system, processes and problems are modelled in an interactive plotting board model based on measurement of the real processes. The possible alternatives are collected and previously evaluated in the interactive environment together with the partner. The defined alternatives are refined and compared in detailed computer based simulation models. The continuous feedbacks and round by round development make us able to implement a well prepared and evaluated solution.

The described interactive training and modelling environment synchronises the plotting board and computer based modelling environment. It supports the alternative finding processes and makes us able to evaluate possible alternatives without programming.

The interactive environments are developed continuously project by project, what make us possible to model more and more logistics problems. Furthermore the computer based administration process development is in progress to the more flexible modelling.

## 6. ACKNOWLEDGEMENT

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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