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MODELLING OF LOGISTICS PROCESSES AND SYSTEMS

PART XVII

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PART XVII

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Marek Ciesielski

Department of Logistics and Transport, Faculty of Management,
Poznań University of Economics and Business

SUPPLY CHAINS – A THEORETICAL AND METHODOLOGICAL PERSPECTIVE

Abstract

This paper generally indicates the need to improve the methodological order in the studies on supply chains. It discusses the following issues: defining, hypotheses and detailed theorems, generalizations, existing theoretical achievements, hypothetical models in research, usability of the theory for economic practice. This approach towards the research process allows to view it globally, from defining the object of research to the practical application of its results. Thus, the article proposes several recommendations for beginning researchers. The overall result of this study is to identify the need for greater order of methodological research on supply chains.

Keywords: model, order research, supply chain, theory, methodology

Introduction

This article mainly aims at expanding the discussion on theoretic and methodological grounds of research into supply chains. The assessments and recommendations have been presented in an unconditional form so to facilitate the criticism thereof. The criticism might primarily pertain to the list of such major issues as:

– defining,
– hypotheses and detailed theorems, generalizations,
– the achievements in the field of theory,
– research – explanations (hypothetical models),
– usability for economic practice.

It needs to be remembered that numerous processes intertwine in academic research. Formulating hypotheses intertwines with explaining; the research might

lead to rejecting hypotheses as well as to falsifying theories, and a correctly formulated definition is essential for providing accurate explanations.

This approach towards the research process allows to view it globally, from defining the object of research to the practical application of its results. Thus the article proposes several recommendations for beginning researchers. These, however, need to be read independently as this article is not a textbook (basic categories have been marked in bold).

1. Defining

The term definition contained in this theoretical and methodological toolkit seems to be surprising. However, many years of experience with the issues of defining within the area of research into supply chains and in the whole management studies makes the author devote a few sentences to the notion of defining. Let us brush upon the definition of definition. A real definition is a sentence characterizing an object or objects of a certain kind which can only and exclusively be ascribed to these objects (Ziembiński, 1995). A nominal definition, however, is as an expression which, in some way or another, provides information on the meaning of a word or words (the words being defined) (Ziembiński, 1995).

There is one more task that the authors of the definition expect it to perform. They want it to contain at least basic knowledge about the defined notions, particularly about the aims of using and managing supply chains. It may happen that the idea of supply chain management is hidden inside the definition of another notion. For instance, "As we see it, logistic management is an activity which creates an all-embracing concept of logistic projects which deals with their course within an organization as well as at its partners' side. The concept also involves coordination of its broadly understood realization by appropriate organizational units by means of appropriate instruments of management and supervision" (Krawczyk, 2001, p. 68).

Even very accurate definitions contain unnecessary conditions, e.g. "Supply chains are networks of partners who collectively transform the basic raw material (the phase of supply) into finished products (the phase of distribution) of a concrete value designed for the end buyers and take care of returned products at each stage" (underlined by M.C.) (Harrison, van Hoek, 2010, p. 34).

The described phenomenon causes chaos as regards even the elementary issues. The authors' intentions are good. One needs to take care of returns. This, however, is just a reflection of wishful thinking, the faith in the magic of the words; if we include certain values in the definition, then they will be realized. The only explanation which could exclude the magic would be an assumption that it is easier to write a wishful definition than a real one. And this definitely is not the case.

2. Detailed hypothesis of the theorem and generalizations

The term science is commonly associated with the word theorem. With respect to research into supply chains, certain reservations must be introduced though. A theorem is a sentence containing an implication where the first part is an antecedent reason and the other a consequence. On the other hand, law is a justified and verified general statement (of universal importance). For the sake of clarity, let us assume that a structured set of laws is called a theory. In the area of research into supply chains one cannot formulate such theorems and laws. In all of the management studies either sentences with a small quantifier are constructed or hypotheses. There are primarily detailed theorems and the so called historic generalizations. As far as the detailed theorems are concerned, the subject constitutes a general name whereas the object pertains to but a few of its referents. The so called historic generalizations, "which just as the law of science may have a general (with no exceptions) or a statistical nature, have one distinctive feature, i.e. the fact that their subject is a general historic name or the scope of their subject is additionally limited by time and space coordinates or, equal to theses coordinates, historic or geographic terms" (Nowak, 2017, p. 207).

Subsequent research might increase the scope of importance of historic generalizations which are sentences with a small as well as large quantifier and sentences of various levels of assertion (the conviction that they are true). Detailed sentences are those with a small quantifier, e.g. some companies view supply chain management as the basis of competition (some is the key word here). Most sentences with a large quantifier, e.g. all companies compete by means of supply chains have a low level of assertion.

In view of the above it might be assumed that all sentences referring to theory are merely hypotheses and thus the Ajdukiewicz rule of rational justification might be accepted as it says that each sentence should be uttered as powerfully as its justification is (and on the same level of assertion). Therefore the word hypothesis might refer to each and every sentence formulated within scientific research or simply be understood as an assumption. It is recommendable to pay attention to the definition provided by Babbie: "hypothesis is a defined and testable expectation regarding the reality, formulated against a more general statement; more broadly, it is predicting the nature of things based on theory. It is a statement that if a variable is accurate, then a particular phenomenon should occur" (Bogdanienko, 2008 , p. 150). It clearly refers to such logic where a thesis if formulated and proven by testing its logical hypotheses.

The above remarks are decisive on the manners of testing hypotheses or theorems on supply chains. These either confirm or disconfirm such hypotheses.

The literature on supply chains does not specify whether a theorem was formulated or a generalization. This may be exemplified by the following sentences:

1) Companies dependent on key external resources can improve their economic stability through vertical coordination;
2) Companies which encounter uncertainty regarding key external resources can improve their stability through vertical coordination;

3) There is a positive relation between vertical coordination and interaction of uncertainty and dependence on resources (Carter, Rogers, 2008, pp. 372–373).

The above cannot be considered as the laws of science due to the use of such expressions as "they can" as well as the fact that the described interdependencies and relations pertain solely to contemporary economic conditions.

To sum up, the research into supply chins produces sentences such as "Benetton is the best manager of supplies and deliveries" as well as such detailed sentences as:
– at most some A are B (at most but not all),
– at least some A are definitely B.

There are also the so called placement sentences where the subject is a universal notion and the object is of a historic nature.

In management studies abduction is a particularly reasonable way of thinking, including the studies of supply chains. Abduction can be the main instrument of explanation in these studies. Concluding by means of abduction involves searching for either the most probable explanation for a given set of facts, or simply creating explanations for a given set of facts. In the former case, the principle of the best explanation is employed. Abduction can lead to understanding surprising explanations or to explaining information which evokes curiosity (Urbański, 2009, p. 10). When Charles Darwin explained the reasons for different shapes of beaks of various species of birds during a sea voyage on H.M.S. Beagle, beyond any doubt, he employed abduction.

The scheme of abductive reasoning is as follows:
– a surprising phenomenon C is observed,
– we state that if A was true, the occurrence of C would be obvious,
– we suppose that A is true.

This reasoning is therefore different from the basic explanatory scheme which can be presented as follows:
– the applied theoretical achievements,
– explanans:
  • the level of oil prices influences the speed of ships on major marine routes,
  • in the period under examination, the speed of ships decreased.
– explanandum:
  • in the period under examination, the prices of oil grew.

The conclusion drawn (explanandum) certainly needs to be tested.

In the case of abduction the reasoning would look as follows:
– we notice a decline in the speed at which ships go,
– if the prices of oil grew, the decline in the speed would be obvious,
– we suppose that in the period under examination, the prices of oil grew.

It is extremely vital that whilst studying supply chains, the basic methodological assumptions were always defined and that the background theoretical achievements were cited. This is the minimum condition of knowledge development by formulating and rejecting hypotheses. In the area of study on supply chains these have been largely neglected.

3. The theoretical achievements

Various theories might be used for constructing theoretical basis of research into supply chains. For instance, in the following hypothetical model, a theory of oligopoly was used along with the theory of price equilibrium, the contract theory, the theory of strategic management as well as the theory of domination. Ketchen and Hult (2007, p. 575) pointed at a huge set of useful studies on improving supply chains:

– transaction costs theory,
– agency theory,
– dependence on resources theory,
– institutional theory,
– game theory,
– theory of chains,
– strategic choice theory,
– social capital theory.

All of the above mentioned theories have already been tested for their usability for explaining the supply chain related phenomena. One might expect that as the supply chains develop, it may be necessary to reach for other theories. For instance, if the processes of re-industrialization keep on developing and if supply chains dramatically change along with these processes, then the explaining thereof will call for another theoretical bases.

A generally understood theory originates in practice and refers to practice. This is illustrated in figure 1.

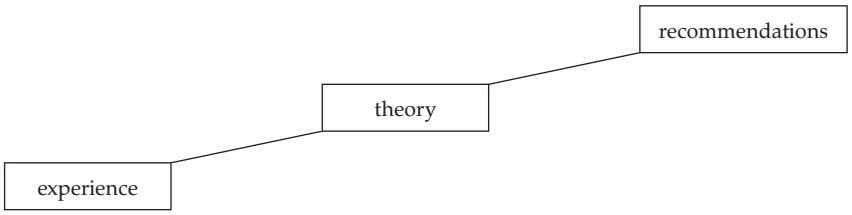


Figure 1. General approach to theory
Source: (Such, Szcześniak, 2006, p. 27)

Theory (hypotheses, generalizations) is formed as a result of observation and empirical research. The value of theory results from the value of recommendations formulated based on such theory.

The generally accepted diagram of knowledge acquisition is presented in figure 2 below.

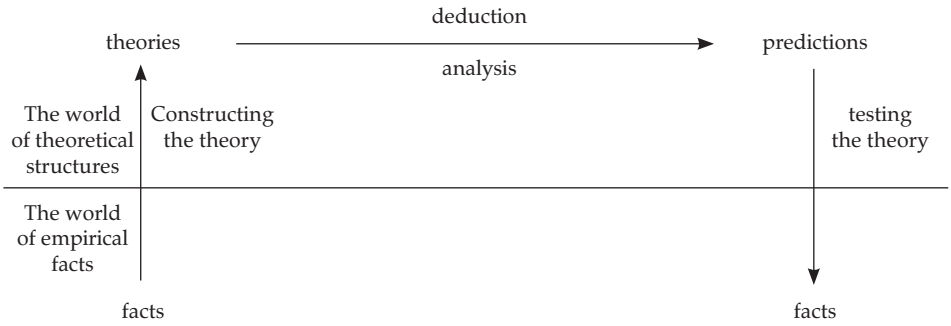
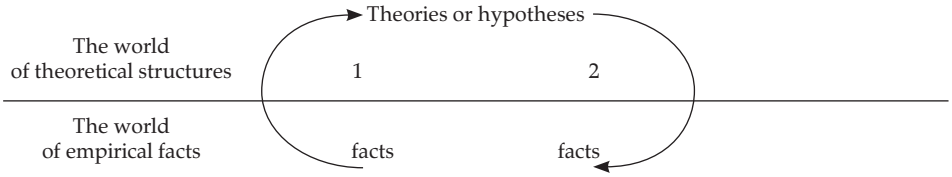


Figure 2. General approach to theory
Source: (Such, Szcześniak, 2006, p. 29)

The diagram involves building theories based on facts, deducing and making predictions based on the theory and putting the theory to test by confronting the predictions with facts. This means going through the stages of facts, theories, predictions and facts. For various reasons this scheme cannot be fully utilized. Then the results of such simplification need to be defined. If at the beginning of the cycle (at the stage of facts) a false statement is assumed (e.g. with respect to the aims and strategies of an organization), then any further stages and steps of the diagram might be false, especially deducing from theory. For instance, this happens to research on pro-ecological behavior of organizations. The next step, deducing and making predictions based on theory may, yet it does not have to, lead to discovering false statements. Deducing is a reliable way of thinking, the direction of deduction is the same as the direction of implication. Regretfully, it can rarely be used in research within economic sciences.

It is difficult to apply this diagram to economic sciences in general and to research on supply chains in particular. Therefore, in research practice a limited diagram of knowledge acquisition is applied. This means that the step of deducing in order to make predictions is omitted. Thus the diagram consists of just two steps: building theories or hypotheses and testing the theories. Just like in the basic diagram, reasoning starts at the level of facts. It finishes at the same level, yet the theory is tested directly by confronting it with facts and not, as in the original diagram, indirectly, by confronting predictions with facts. The limited diagram is presented below in figure 3. Removing one step might not lead to discovering the falsity of facts which are found at the beginning of the diagram. The omitted step is a firewall against falsifying the subject of studies.



1 – building theories or hypotheses
2 – testing theories or hypotheses

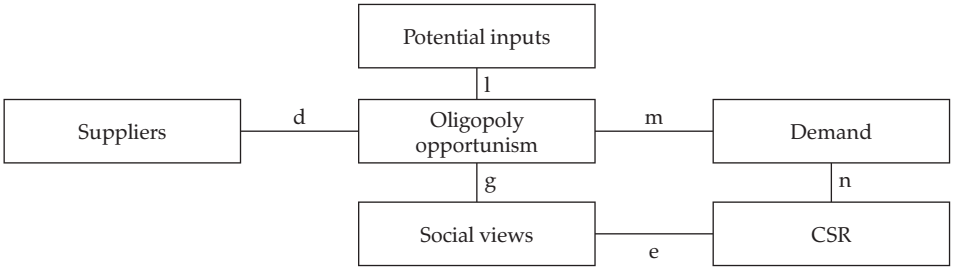
Figure 3. Limited diagram of knowledge acquisition
Source: author's own based on (Such, Szcześniak, 2006)

In the limited diagram, testing involves finding a large number of cases supporting the theory as compared to the number of cases that were used to construct hypothesis. Then it must be considered whether the hypothesis is not a mere historic generalization or a detailed sentence.

One needs to remember that the discussed phenomena might be strengthened by the researcher's epistemological bias or by making the research excessively theoretical. Moreover, each sentence might be interpreted in various ways. On the basic level of research, the epistomological approach reveals itself as a general approach towards economic phenomena, or towards the type and force of active factors and the probability of their occurrence. A broader issue pertaining to the subject of research is also important in studying supply chains. This issue pertains to all of the management studies and economic studies and it depends on a wide acceptance of an assumption of the normal distribution.

4. A hypothetical model

One of the aims of this article is to formulate a descriptive hypothetical model of contemporary supply chains in consumer goods branches. It was assumed that the three major factors that influence contemporary supply chains include the oligopolistic nature of the market, price pressure and the phenomenon of domination within supply chains. It is recommended to use an explanatory diagram, especially the abduction, to discuss these phenomena. Such an attempt was made in this article. Numerous factors and their variability make it impossible to use more precise manners of explanation in the research into supply chains. The above discussion has resulted in creating a hypothesis regarding the increasing levels of competition amongst supply chains and within supply chains in the future.



l – keeping the limit price,
d – suppliers look for ways of cutting the costs and prices, exerting pressure on sub-vendors,
m – controlling the demand by the brand and marketing,
n – low prices for the end consumers,
g – the threat of social ostracism,
e – actions taken in line with CSR prevent boycotting by end recipients

Figure 4. Hypothetical model of the abductive manner of thinking
Source: (author's own)

Assuming the abductive manner of thinking, one might build a hypothetical model, as in figure 4. Let us consider the following hypotheses:

H1. Domination over the suppliers allows limit pricing.

H2. Suppliers keep low prices thanks to cooperating with environmental unfriendly subsuppliers.

H3. Price competition lowers prices and supports limit pricing.

H4. Low retail prices and CSR prevent effective social criticism (exploiting suppliers and subsuppliers).

H5. H1, H2, H3, H4 set a trap which is difficult to free from. The attempts to raise prices may end up with a disaster for the company.

The dominating chains act primarily in the environment of oligopoly. On one hand, they fiercely compete with each other, and on the other, they adopt the limit price policy and keep the margins on a low level (the contestable market). Thus they:
– prevent entrances,
– intimidate substitutes,
– obtain satisfactory margins (Ciesielski, 2014, p. 4).

Domination over suppliers is the best way to create barriers against entering the branch of retail trade. (*Quasi* margins are not only charged upon suppliers, they are also created by freezing the pay on a very low level). With prices on the level of limit price and with domination over suppliers, this is the supplier who has to cope with the results of the dependencies described in the model above. The results include low prices and disadvantageous conditions of cooperation.

5. The usability of theory

In this part of the article, the question of practical usability of theory is discussed. A question arises whether the achievements of the research on supply chains allows

the use of the notion of cognitive schema which is an integrated network of knowledge, beliefs and expectations pertaining to a particular format or aspect of reality (Maruszewski, 2011). Managers, advisors and academics give various meanings to various notions and even use various sets of notions. There are various opinions (e.g. process reengineering is useful in any conditions VS the BPR concept mainly causes losses). Each of the participants of management process must construct cognitive schemes pertaining to all the elements of the process which is being managed (e.g. we have to have substantial stocks as this guarantees short time of delivery VS we can minimize stocks and still keep delivery times very short). In other words, a cognitive scheme is a network structure involving certain activity. The scheme contains mutually connected principles of operation, for instance the principles of competition. According to its assumptions, the theory of cognitive schemes refers to management. In the article regarding management as a whole Krzakiewicz (2012) mentions mental models (schemes) which give direction to managers' activities.

The concept of management is in its principle a good cognitive scheme. It may either merely point to the need and profits of looking at other companies (Benchmarking) or be based upon one opinion, e.g. the make or buy decisions are of vital importance for the company's competitiveness, thus they need to be made following a deep analysis and their effects need to be continually monitored (Outsourcing). Such concepts must be evaluated positively when:

– they offer cognitive schemes which are in line with reality,
– they ensure a better choice of topics and information and a better interpretation,
– they are fashion independent.

It must be clearly stated that the intensive development of supply chain studies and improving the methods of supply chain management has already lead to formulating numerous recommendations and proposals of varied scopes – from the logistic system of a single company to global supply chains. The concept which is being developed in companies and networks of organizations pertains to real events and depends on the current fashion to a relatively small degree. The concept of supply chain management transforms into cognitive schemes which involve all the key questions. Normative knowledge on supply chain management used to be reflected in the approach to these networks. The researchers stressed the need to assume a system approach along with process and network approach. The strategic role of supply chain management used to be underlined. Instructions how to build relation within the networks were prepared. Rapid development to knowledge justifies defining it as a concept and cognitive scheme. The concept of supply chain management has two distinctive features which make it stand out in the area of normative knowledge of management:

– it largely uses the values contained in such concepts as Lean Management,
– it employs management methods, such as SCOR, in the developing normative knowledge.

The latter feature especially favors the formation of better practice.

Conclusions

This paper generally indicates the need to improve the methodological order in the studies on supply chains. More specifically, this pertains to the need to intensify the efforts to further systematize research problems in the area of studies under discussion. The same must be applied to arranging the theoretical bases. The third proposal is of no lesser importance, i.e. the methodological issues must not be avoided in the research into supply chains.

Although the above studies have been carried out for a relatively short time, the knowledge acquired is so vast and varied that it is possible to develop it further via refuting, i.e. putting forward, defending and rejecting theses. Constructing models and refuting arguments constitutes a potential driving force of development of supply chain studies. Just to start with, bold hypotheses should be formed and hypothetical models for the most important phenomena regarding supply chains should be constructed.

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Corresponding author

Marek Ciesielski can be contacted at: marek.ciesielski@ue.poznan.pl

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Eva Nedeliaková[a)], Michal Panák[b)], Štefan Kudláč[c)]

a) Department of Railway Transport, Faculty of Operation and Economics of Transport and Communications, University of Žilina
b) Department of Railway Transport, Faculty of Operation and Economics of Transport and Communications, University of Żilina
c) Department of Railway Transport, Faculty of Operation and Economics of Transport and Communications, University of Żilina

PROCESS-ORIENTED MANAGEMENT APPROACHES ON LOGISTIC SYSTEMS

Abstract

This article is focused on research results within logistics systems in railway transport application. These views strive to encourage modern process-oriented management approaches that should be applied for supporting carriers' competitiveness on the transport market. It emphasises the importance of their using and permanent monitoring of quality services. Facing tough competition from other means of transport, railway carriers should be able to provide their customers with a full range of well-prepared transport services. Process-oriented model, solved in the research, verified in practice, can be used in a uniform manner. It is unified and thus applicable in different branches and types of business.

Keywords: railway transport economics, logistics system

Introduction

Logistics system is influenced by quality of chosen management approach. In the appreciation of quality of the system in a company, it is important to consider the approach those methods, techniques and quality models, which combine objective and subjective components of rating (Majerčák, Plevko, Majerčák, 2014, pp. 299–301). Progressive approaches towards the service quality rating must in general find the current level of quality. Other more these attitudes reveal the causes of dissatisfaction of both customers and the organization employees, finding the strengths and weaknesses of organization and also its suppliers and

competitors. They should offer relevant data for processing constant improvements of quality and bring qualified, measurable outputs with the ability to evaluate trends in the quality.

Nowadays, mainly important approaches are focused on processing, machine learning and artificial intelligence. Digitalisation can be both a risk and opportunity for logistic systems. Is it automation of services good approach (Majerčák, Majerčáková, 2014, pp. 520–523)? It can mean losing personal contact with customers as has happened in various types of industries. On the other hand, the ability to connect with customers through information technologies and various computer systems enables much easier to offer new services and automates load monitoring throughout its entire journey (Majerčák, Nedeliak, 2010, pp. 81–84).

According to above mentioned facts, it is very important to launch process-oriented management approaches within logistic systems with integrated planning that is the activity of developing products and processes required to meet customers' needs. It involves a number of universal steps defined by Juran and DeFeo (Gitlow *et al.*, 1989, p. 784):

– define the customers,
– determine the customer needs,
– develop product and service features to meet customer needs,
– develop processes to deliver the product and service features, and
– transfer the resulting plans to operational personnel.

As Juran intended and experience has shown, the term universal implies the activities are applied across any organization at various levels, so they are applicable under the logistics chain. Traditional strategic planning starts by answering two simple questions: "What is our business?" and "What should it be?". It is not forecasting and it is necessary precisely because we cannot forecast the future of the organization and it's competitor's development easily. It deliberately seeks to upset the probabilities by innovations and organizational change (*International Railway Journal IRJ*, 2015, pp. 12–13).

Within the scientific research undertaken by the University of Žilina, Department of Railway Transport, were solved different ways of process-oriented management with software support. One part of methodic had been already successfully applied in the conditions of transport enterprise, carrier-offering services of rail passenger transport.

Railway transport is an important branch of transport. Its crucial advantages are the lowest negative impact on the environment, the highest level of security among the land transport modes, the lowest specific energy consumption, high degree of safety and others. These factors must be monitored by the management of railway companies so it goes hand in hand with the world traffic trends. Characteristic is connecting of speed, safety, and economy, while highlighting quality as an integral part of the services offered in passenger and freight transport.

The goal of the research was fostering this transport mean by solving the current issue necessary to keep railway transport on track of the transport market concerning the search for innovative options of process-oriented management approaches.

1. Methodology of the research

The process-oriented management approach suitable for the conditions of the railway transport must respect its specific properties, which are unrepeatability, impalpability, their use right at the time they are provided and particularly changeability, which is significant factor in the conditions of rail transport as well. These peculiarities influence the quality of service regarding the constantly increasing requirements. In the contemporary literature the problem of process-oriented management is discussed mostly theoretically, often only in general which absents the usage of approaches particularly in the conditions of railway transport.

New approach to process-oriented management, in accordance with the research, must consider criteria for performance excellence framework, such as leadership, strategic planning, and three kinds of focuses, such as customer focus, workforce focus and operation focus.

Within considering this approach, various types of constraints should be contemplated. Constraints could be physical (equipment, railway infrastructure, facilities, materials, railway vehicles, people) or they could have another forms (laws, regulations, principles of doing business, choose of transport markets).

Constraints in the railway passenger transport were defined as follows (Nedeliaková *et al.*, 2017, p. 194):

– market – not enough demand for a product/service, the lack of customers,
– resources – not enough equipment, vehicles, infrastructure faults, people, facilities to satisfy the demand for products,
– service – inability to obtain the quality needed to satisfy the demand,
– supplier – unreliability and inconsistency of supplier or excessive lead time in responding to orders,
– financial constraints – the lack of financial sources for modernisation or purchase of new vehicles, equipment of rail infrastructure,
– knowledge – competence, information or knowledge to improve business performance,
– policy – regulation, rules, any law, business practice that inhibits progress toward quality goals achievement.

One of above defined focuses was workforce and its relationship to other areas of improving quality, where specific constraints may appear. The Quality Improvement (QI) story is a format for employees to persuasively present process improvement studies to management (Sekulová, Nedeliak, 2013, pp. 67–75). Employees trying to improve quality have found that their ideas and recommendations are more persuasive when based on facts rather than opinions and guesses. QI stories can be used to facilitate the transition from the old to modern style of process-oriented management.

Very good example of application of QI story for transportation chain is rail vehicles faults, this example is simplified and selected from wider research results. Figure 1 shows QI story in railway vehicles faults.

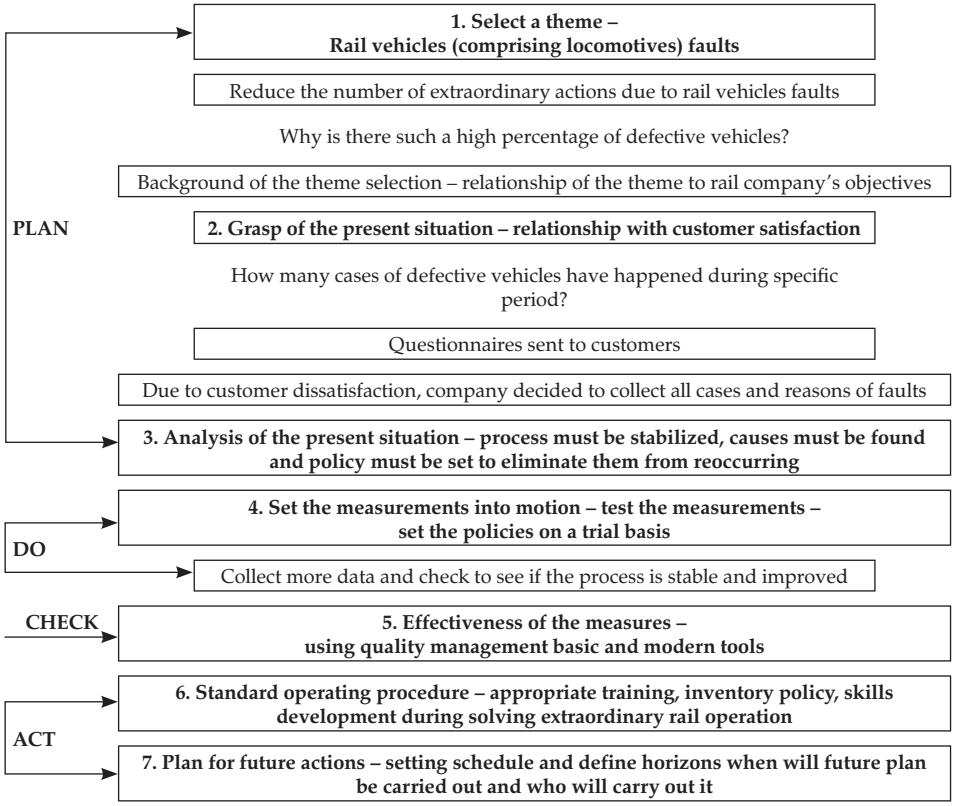

Figure 1. QI story and application in rail vehicles faults
Source: (Nedeliaková *et al.*, 2017)

Quality Improvement stories were applied in conditions of rail vehicles. These stories should consider also relationship between the quality, process-oriented management and the total loss created by that product to society, the necessity of continuous quality improvement and cost reduction for the rail company's health in improving competitiveness (Pyzdek, Keller, 2013, p. 678).

2. Software support and research results

Described methodology allows the monitoring of the quality of the processes provided throughout the transportation chain, thus encompassing the quality before the realization of the transportation, during it and after the end of the transportation. In comparison with previously used methods, this methodology is unique, universal and applicable to various types of companies in the context of the introduction of new trends in process-oriented quality management. It was supported by software solutions using various quality areas defined within the research and

software support through BPMN (Business Process Modeling Notation), EPC (Event-driven Process Chain) and UML (Unified Modeling Language).

Figure 2 shows the fragment of the software support including the modelling of one of the processes using the BPMN application and figure 3 demonstrates the fragment of Unified Modeling Language application.

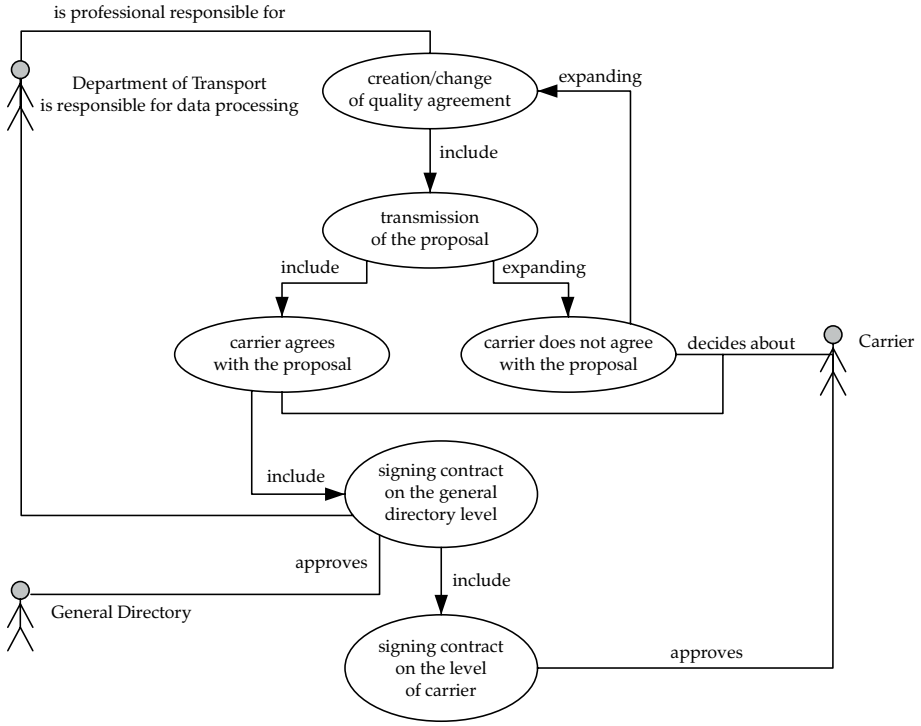

Figure 2. The fragment of process modelling using the BPMN application
Source: (Nedeliaková *et al.*, 2017)

Various software solutions were used to gain a better understanding of the processes and to make managers' work easier. These software tools have never been used in railway companies before. This research allowed the use of a new approach to obtain clearer management attitudes. The numerical abbreviations, for example RP 03.05, used in the pictures mean the code names of the processes.

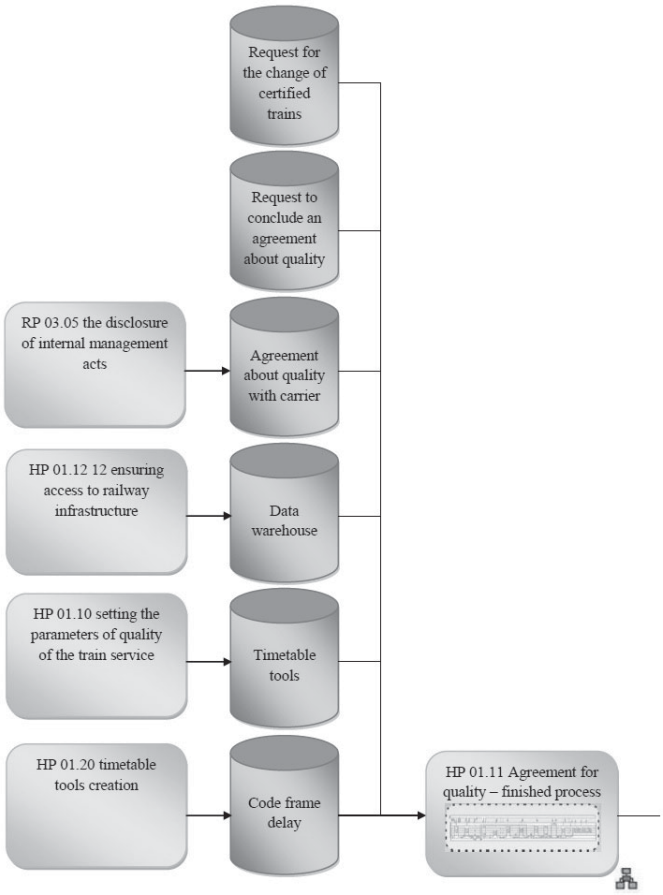

Figure 3. The fragment of process modelling using UML application
Source: (Nedeliaková *et al.*, 2017)

To address the issue of improvement the quality of the processes, the research at the Department of Railway Transport proposes a simple application that consists of a Graphical User Interface. Data about the existing tracks and the trains that operate on the tracks were transmitted to this software application, which is shown in the following figure 4. This interface is currently being extended to include a module to work with quality model (the transition is shown by a red arrow in the picture).

This solution uses dynamic quality models suitable for process-oriented management approaches. They allow taking account of a process character of provided services respecting the expected and perceived quality from the customer's perspective. The universal models can be used in any industry or company. Models provide interesting and new perspective on service quality and show often hidden bottlenecks throughout the process of providing service.

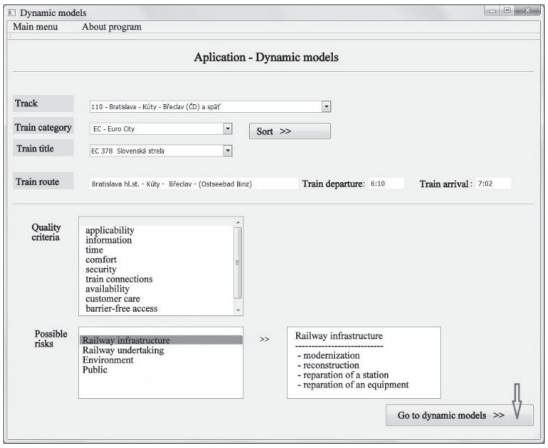

Figure 4. Quality model software solution
Source: (Nedeliaková *et al.*, 2017)

Conclusions

Various types of process-oriented management tools are used all over the world in the application to transport. Railway carriers should apply them in the conditions of ordinary and extraordinary operation. Development in the transport market worldwide includes the rapid growth of technology and globalisation, necessity to eliminate CO_2 emissions, pollution, and energy consumption, and the growing gap between various means of transport. There is also a whole range of social and economic issues. Railway transport has to face lots of problems, congestion is a problem in all countries, but there is a lack of infrastructure in developing countries while in developed countries it is very old.

Sustainable innovation connected with new process-oriented management approaches can help to improve the quality of railway services. But as Mr Masaki Ogata, new president of the UITP says: "we need to know the genuine needs of our customers, which will create the seeds for innovation" (*International Railway Journal IRJ*, 2015, p. 2). Immediate reactions to rapidly changing market environment are required. The research showed new approach that is necessary for support railway transport with emphases customers view. This approach should be an integral part of quality improvement within transportation chains.

New logistics model involves improving quality of the transportation chain by correct selection of service quality criteria. It observes and evaluates quality and on this basis realizes intern audit of logistics chain. This unified quality rating system can be applied for all kinds of service, departments and companies. It is inevitable in terms of strategic decisions in practical company operations. It can become a way out for regulation of service, which increase in quality is urgent condition for keeping companies in competitive business environment.

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Corresponding authors

Eva Nedeliaková can be contacted at: eva.nedeliakova@fpedas.uniza.sk
Michal Panák can be contacted at: michal.panak@fpedas.uniza.sk
Štefan Kudlá can be contacted at: stefan.kudlác@fpedas.uniza.sk

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Rafał Matwiejczuk

Chair of Logistics and Marketing, Faculty of Economics, University of Opole

LOGISTICS COMPETENCES AS THE CORE COMPETENCES OF A FIRM AFFECTING BUSINESS COMPETITIVE ADVANTAGE CREATION

Abstract

Firms are constantly looking for ways leading to competitive advantage creation. Such advantage may be embedded on business success potentials including resources, capabilities and competences. From business competitive advantage perspective, the most significant potentials are competences. The effective and efficient exploitation of the competences may contribute to the achievement of the expected market and economic outcomes by the firm. Such outcomes are the symptoms of business success and the basis for business competitive advantage creation.

In recent years one may notice an increasing significance of logistics seen as the crucial factor (or set of factors) of a firm success as well as business competitive advantage creation. The purpose of the article is to express the most important characteristics of logistics competences as the core competences of a firm in the context of the sustained, long-term business competitive advantage creation. The article is based on the literature review concerning the growing significance of a firm's core competences as well as the possibilities of logistics competences exploitation in business competitive advantage creation.

Keywords: logistics, competences, core competences, competitive advantage

Introduction

Firms are constantly looking for ways leading to gaining and maintaining a sustainable, long-term competitive advantage. Competitive advantage may be embedded, among others, on focusing on business success potentials which comprise resources, capabilities and competences. Additionally, within the firm

competences one may distinguish their two special forms: core competences and metacompetences.

The effective and efficient exploitation of the potentials may significantly contribute to the achievement of the expected market outcomes (customer satisfaction, customer loyalty, market share) and economic outcomes (profit, profitability, ROI) by the firm. Such outcomes are not only the most significant symptoms of business success but also the basis for business competitive advantage creation.

At the same time one may also notice an increasing importance of logistics, perceived as a concept of materials, goods and information flow management. Nowadays logistics is more and more often seen as a critical factor of a firm success and a firm performance, including effectiveness, efficiency and differentiation (Blaik, 2015), as well as a significant factor influencing business competitive advantage creation (Matwiejczuk, 2014).

The purpose of the article is to express the most important characteristics of logistics competences perceived as the core competences of a firm, affecting business competitive advantage creation. The article is based on the critical review of the most significant and influential literature concerning both: 1) the growing role of a firm core competences as well as 2) the possibilities of logistics competences exploitation in business competitive advantage creation.

1. The nature of the firm competences

The most important group of business success potentials affecting business competitive advantage creation are competences. The concept of competences can be perceived – at least – from two major points of view: 1) from the personal perspective and 2) from the managerial (business) perspective.

From the personal perspective, competences are mainly associated with the personal characteristics (features), allowing people (managers, employees) to perform the assigned tasks. Such perception of competences has been associated for many years with Competency-Based Human Resources Management and such competences are referred to as "personal competences" (Dubois, 1993; Illeris, 2009).

From the managerial (business) perspective, which mainly concerns the resource-based stream of strategic management, competences are seen as the bundles of long-term capabilities related to the coordinated use of the resources, actively and widely involved in the goals achievement as well as in the processes, activities and tasks implementation that lead to the expected market and economic outcomes achievement by the firm. Such competences, associated with Competence-Based Strategic Management, are referred to as "firm competences" or "business competences". The basis for their development is the integration and coordination of resources and capabilities, also taking into account the significance of knowledge perceived as a superior firm resource (Matwiejczuk, 2014).

2. Core competences as the superior business success potentials affecting competitive advantage creation

The concept of the core competences was initially associated with the term "distinctive competences", introduced by Philip Selznick (1957). Distinctive competences are the firm competences that enable companies and businesses to adapt to their own goals and programs. Such competences refer to these processes, activities and tasks that a firm is able to perform more effectively and/or efficiently comparing to its competitors (Eriksen, Mikkelsen, 1996).

Charles. W. Hofer and Dan Schendel present the distinctive competences as patterns and characteristics of a firm performance concerning the use of resources and capabilities, supporting the achievement of the firm goals (Hofer, Schendel, 1978).

In Charles C. Snow and Lawrence G. Hrebiniak opinion, distinctive competences represent the wide composition of various and firm specific activities that the firm can conduct more effectively and efficiently in comparison to its competitors operating within the similar environment (Snow, Hrebiniak, 1980).

Giovanni Dosi and David J. Teece emphasize that the firm distinctive competences can be understood as a result of the integration of distinctive capabilities concerning coordination and learning. In their point of view, distinctive competences represent a differential set of capabilities, complementary resources and organizational routines performed by the firm, which – seen as a whole – enable the firm to coordinate the different sets of activities in a way that leads to business competitive advantage creation (Dosi, Teece, 1998).

Bohdan Godziszewski notes that the distinctive competences, which create the possibilities for more effective and efficient use of a firm resources, play the crucial role in the process of the firm competitiveness creation, including business competitive advantage creation (Godziszewski, 2006).

Michael E. Porter and Thomas J. Peters also highlight the significance of distinctive competences in business competitive advantage creation. In their opinion, such competences can be defined as the sets of capabilities which strongly distinguish a firm from its competitors, as well as deliver tangible benefits to customers, and – as a result – contribute to the achievement of competitive advantage by the firm (Porter, 1979; Peters, 1984).

The most important feature of distinctive competences is their strong potential contribution to expected market and economic outcomes achievement by a firm compared to their competitors. Such outcomes are not only the significant symptoms of business success but the basis for sustainable, long-term business competitive advantage creation as well. With the progressive development of the resource-based stream of strategic management, the term "distinctive competences" has been more and more often replaced by the term "core competences". Table 1 provides chosen definitions and interpretations of core competences.

Table 1. Core competences definitions/interpretations by different authors

Author/authors (year)	Core competence definition/interpretation
C.K. Prahalad, G. Hamel (1990)	Core competences are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies
W.C. Bogner, H. Thomas (1994)	Core competences are firm specific skills and features oriented to the achievement of the highest level of customer satisfaction compared to the competitors
G.S. Day (1994)	Core competences are firm capabilities which are "spanning" on individual businesses as well as are supporting these businesses
A.A. Lado, M.C. Wilson (1994)	Core competences comprise all firm specific assets, knowledge, skills and capabilities, which are embedded on a firm structure, technology and processes, as well as interpersonal relationships within the firm
M. Tampoe (1994)	Core competences are technological or managerial subsystem which integrates a variety of technologies, processes, resources and know-how in order to deliver products and services which are the basis for the sustained, long term and unique business competitive advantage creation as well as for business value added creation
D.J. Teece G. Pisano (1994)	Core competences are a set of different skills, practices and complementary resources that allow the firm to compete and achieve the competitive advantage in a particular business
D. Lei, M.A. Hitt, R. Bettis (1996)	Core competences are the capabilities concerning defining and solving of problems, which support a firm growth and development
N. Petts (1997)	Core competences are a unique set of technology, knowledge and skills related to customer needs
H. Thomas, T. Pollock (1999)	Core competences are the knowledge base or sets of capabilities which can be exploited in a variety of "combinations"; they result in benefits achieved by the customer and are difficult or even impossible to duplicate by the competitors
M. Bratnicki (2000)	Core competences are the bundles of resources, processes and capabilities which are the base for business competitive advantage
D.M. De Carolis (2003)	Core competences are an expression of the permanently shaped organizational knowledge, which is difficult to imitate as well as very important in business competitive advantage creation
V. Boguslauskas, G. Kvedaraviciene (2009)	Core competences are the innovative combinations of knowledge, special capabilities (sets of skills), adequate technologies, information and unique operational methods

Source: based on (Bogner, Thomas, 1994; Boguslauskas, Kvedaraviciene, 2009; Bratnicki, 2000; Day, 1994; De Carolis, 2003; Eden, Ackermann, 2010; Lado, Wilson, 1994; Lei, Hitt, Bettis, 1996; Mäkinen, 2005; Petts, 1997; Prahalad, Hamel, 1990; Ray, Ramakrishnan, 2006; Tampoe, 1994; Teece, Pisano, 1994; Thomas, Pollock, 1999)

It is quite commonly accepted that the concept of core competences has been introduced within the field of strategic management by C.K. Prahalad and Gary Hamel (Prahalad, Hamel, 1990). According to the authors, core competences are "collections" of the capabilities characterised by the following features:
– "direct" contribution to the customer value added creation,
– uniqueness compared to the competitors,
– copying difficulties,

– universality concerning the use of core competences within different markets and for different products.

The most fundamental features (attributes) of core competences are presented in the table 2.

Table 2. Fundamental features (attributes) of core competences

Characteristics of core competences	Features (attributes) of core competences
Value added/costs	Core competences: – make a significant contribution to the creation of unique – compared to the competitors – value added for the customer, according to his preferences and expectations – may be helpful in the optimising of the total costs level and structure – create the possibilities of the cost assignment to the specified operations, processes, activities and/or tasks
Competitiveness/ substitutability	Core competences: – are unique in comparison to the competitors' competences – are difficult to recognize and imitate by the competitors – do not have close (strong) substitutes – significantly contribute to the business competitive advantage creation
Lasting/permanence/ versatility	Core competences: – are lasting for a long time compared to the "basic" competences – can be used for differential markets and differential products

Source: (Matwiejczuk, 2014)

3. Logistics competences within the "general" firm competences system and their influence on business competitive advantage creation

Firm competences, including personal competences, make up the "general" firm competences system. Within the system one may distinguish four basic levels of competences which may significantly affect business competitive advantage creation (fig. 1):

1) A firm/corporation competences, concerning a firm/corporate mission, vision and strategic directions of business development;
2) Business unit competences;
3) Functional competences related to the firm functional areas;
4) Personal competences.

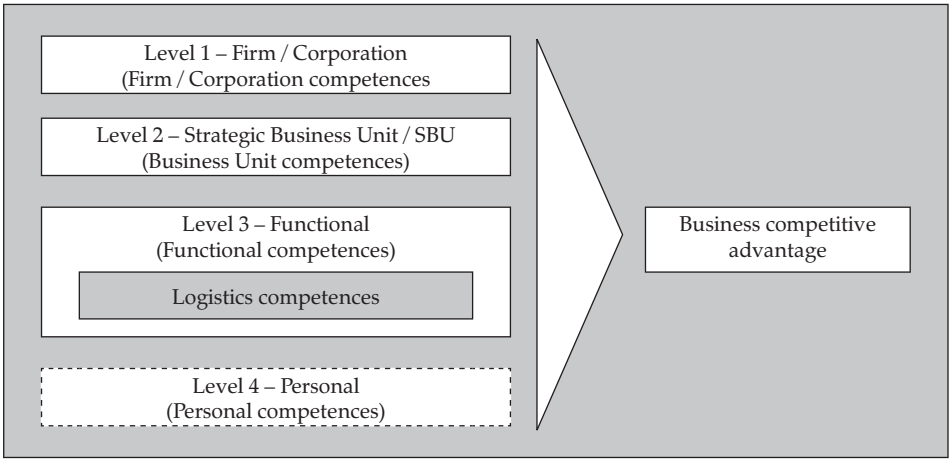

Figure 1. The levels of competences affecting business competitive advantage creation
Source: based on (Orava, Brännback, 2005)

According to Markus Orava and Malin Brännback, competences related to different functional areas of a firm (logistics, marketing, production, etc.) can be located between strategic business unit level of competences and personal level of competences concerning the competences of people (managers, employees) performing designated processes, activities and tasks in different functional areas of a firm.

Functional competences integrate processes and activities conducted within the strategic business level as well as processes and activities conducted by individual managers and employees. The common purpose of all competences levels (corporate, business, functional, personal) is the sustained, long-term business competitive advantage creation.

One of the most important competences within the firm, as well as within the entire supply chain are logistics competences. In recent years one may notice the growing importance of strategic decisions related to logistics and supply chain management areas. Such decisions can significantly contribute to the creation and exploration of new premises, opportunities, possibilities, etc. related to business success as well as to business competitive advantage creation (Blaik, 2017; Esper, Fugate, Davis-Sramek, 2007; Matwiejczuk, 2015; Mollenkopf, Dapiran, 2005).

The results of the research conducted by the Technical University in Berlin as well as German Logistics Association show that contemporary firm strategies concerning planning and implementation of the logistics systems and processes are frequently concentrated on core competences (Blaik, Matwiejczuk, 2008). In the process of business competitive advantage creation the firms give priority to the identification of the value creation sources and processes. Within such sources and processes logistics plays an important role. Logistics, including logistics concept, systems, processes and – first of all – logistics competences, may significantly contribute to customers' needs and wants fulfillment by the creation of the so-called "place and time utility" by the firm.

Logistics competences are the result of the integration and coordination of logistics resources and logistics capabilities (Blaik *et al.*, 2013). As it is noted by Andreas Sennheiser and Matthias J. Schnetzler, the primary condition for logistics competences development is previous identification of adequate logistics capabilities, which are based on logistics resources (Sennheiser, Schnetzler, 2008). The integration of resources and capabilities relates to so-called "synergistic effects", i.e. benefits, opportunities etc., resulting from the possibilities of simultaneous use of a comprehensive base of differentiated resources (referred to as "resources compositions"), which are precisely assigned to the specific logistics capabilities (referred to as "capabilities compositions"). In turn, coordination of resources and capabilities comprises the managerial processes (sets of activities), which create the opportunities for effective and efficient use of differentiated resources and capabilities compositions, leading to the expected market and economic outcomes achievement by a firm. As a consequence, the logistics competences can significantly contribute to business success achievement as well as to business competitive advantage creation (Matwiejczuk, 2014).

Logistics competences as the core competences of a firm "directly contribute" to the creation of unique value for customer. The uniqueness of the customer value means that such value is easy to clearly distinguish it from the values offered by competitors (Matwiejczuk, 2006). The creation of customer value is the base for the creation of value for a firm, related to return on sales, customers profitability or market share. As a result, logistics competences as the core competences of a firm may be one of the most significant factors affecting sustained, long-term business competitive advantage creation.

Conclusions and further research

One may notice a growing importance of logistics concept in contemporary strategic management, particularly in the resource-based stream of strategic management. Within the resource-based stream one of the most significant firm's competences are logistics competences. Logistics competences play an important role not only on today's markets but also within today's business models and are more and more often perceived as the key factors affecting the sustained, long-term business competitive advantage creation.

Logistics competences as the core competences of the firm not only play the crucial role in business competitive advantage creation, but also need further and deeper research concerning their influence on business success, market success, as well as long-term firm's competitive position on the market.

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Corresponding author

Rafał Matwiejczuk can be contacted at: rmatwiejczuk@uni.opole.pl

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Dariusz Milewski[a)], Bogusz Wiśnicki[b)]

a) Department of Transport Systems and Policy, Faculty of Management and Economics of Services, University of Szczecin
b) Department of Integrated Transport Technologies and Environmental Protection, Transport Engineering and Economics Faculty, Maritime University of Szczecin

MODELLING INTERMODAL TRANSPORT SYSTEMS – DIRECTIONS FOR SCIENTIFIC RESEARCH

Abstract

The authors of the article here describe scientific achievements in the field of transport modelling with emphasis on intermodal transport models. Already developed models, described in the scientific literature and used in practice are discussed and their relevance to various scientific phenomena and relationships assessed. The authors point out the limitations of these models and submit the requirements that should be met in order to create effective decision-making tools. The models should provide support to achieve the research objectives for which they were developed (the observation of phenomena, the influence of different factors on the analysed phenomena, streamlining the decision-making process, optimal solution choice).

Keywords: transport modelling, intermodal transport systems

Introduction

Economic science examines economic phenomena: their nature, causes, mechanisms that guide them and relationships between them. However, knowledge concerning these phenomena should serve not only for scientific purposes but also, although indirectly, practical purposes and should be built on the basis of identified market processes. This latter principle concerns issues of economic process modelling.

A model in scientific research can be defined, more or less, as an attempt to provide an accurate representation of reality (actual systems, processes or a single phenomenon) (Łatuszyńska, 2004, p. 96; Kubicki, Kuriata, 2000). Hence, a scientific

transport model can be used to observe transport systems and processes, which are discussed further. It can be also used as a decision-making tool for solving transportation system problems. For this purpose, scientific models can take different form. This can take, for example, the form of a mathematical formula reflecting transport process efficiency.

The creation of economic models should begin with identifying real problems in the economy. Models should be reviewed for their usefulness for solving specific practical problems. The form and structure of the model should reflect the research objectives of modelling (Krawczyk, 2001, p. 3; Lisiecki, 2001, p. 66; Gomółka, 2000, p. 45).

In recent years, many transport models have been created that were supposed to support transport operators and institutions of transport policy, especially in the planning of transport systems and in decision-making processes (de Jong *et al.*, 2013, pp. 347–371). Although achievement in this area is abundant, it is justifiable to ask the question about the practical usefulness of these models, particularly of those serving as decision-making tools, aimed at increasing the efficiency of transport and logistics processes. The large number of publications in this field and the variety of models proposed by their authors can give the impression that research in this field is highly advanced and doubts can be raised as to the necessity for further research. Paradoxically, by analysing the scientific achievements one might wonder why still new models are being developed. One could ask the question: do these models fulfil their role? Do they really solve problems for which they have been developed? Do they correctly reflect the modelled processes?

The authors' objective is the analysis of already developed models of transport processes and systems and their applicability in solving problems of intermodal transport.

Intermodal transport is understood as a complex transport system using different transport modes for carriage of intermodal loading units (containers, swap-bodies, semitrailers, logistics units). The specificity of the system is the use of a dedicated transport technology, a high degree of intermodal integration required and a large number of factors of internal and external nature affecting the efficiency of this form of transport. This causes great difficulty in reaching an appropriate cost-effectiveness of logistics systems using intermodal transport technology. In particular, achieving effectiveness is hampered by the large diversity of external circumstances such as economic development, the standard of transport infrastructures or transport policy tools used in different countries.

Here in the authors have developed an analysis of transport processes and systems models described in other scientific publications and literature sources. On the basis of this analysis the authors suggest directions for further research on the use of models for solving current problems relating to intermodal transport.

Review of the literature in the field of used transport models

The variety of transport models, and also models in general, first follows the diversity of the purposes for which they were created.

One important group are decision models, among which models of an algorithmic character can be distinguished, by which optimal solutions to the problems of decision-making are found (e.g. the problem of planning vehicle routes [The Vehicle Routing Problem VRP]. To solve these problems different methods may be used (Ants System, Graph Colouring problem, Quadratic assignment problem) (Reimann, Doerner, Hartl, 2002; Colorni, Dorigo, Maniezzo, 1991, pp. 134–142; Costa, Hertz, 1997; Stützle, Dorigo, 1999, pp. 33–50). As an alternative to this type of model, mathematical formulae can be used to predict the consequences of making certain decisions in transport in the form of a certain level of efficiency (e.g. a model of the total transport costs) (Twaróg, 2003, p. 63).

The second large group of models are models that reflect the actual functioning of the systems, which allow tracking of specific phenomena or processes in transport systems.

The best known models of this type, which also have an electronic form, are listed below (de Jong, Gunn, Walker, 2004, pp. 103–124):

– SAMGODS – Swedish model of the domestic freight transport system,
– NEMO – Norwegian model of the domestic freight transport system,
– WFTM – Belgian model of regional freight transport system in the region of Wallonia,
– Italian model of the domestic freight transport system,
– Dutch models – TEM (Economical Model of Transport) and SMILE (Strategic Evaluation Model for Integrated Logistics),
– Models used in the UK for forecasting domestic freight transport,
– SCENES – European Transport Scenarios,
– NEAC – European models,
– Models for specific international corridors (e.g. in Scandinavia, Alpine crossing).

Table 1 shows the areas in which each different model of freight transport system in Europe was used in the projects of the European Commission.

Table 1. Review of the models of freight transport systems

Project reference	Freight transport model used	Years simulated	Scenarios/policies studied for future years
Strategic Environmental Assessment (MEP *et al.*, 2000)	STREAMS	1994 2010 2020	Reference scenario Common Transport Policy scenario Trans European networks (TEN-T) scenario Rail only TEN-T scenario
Forecast 2020 (NEA, 2000)	NEAC	1995 2000 2010 2020	Reference scenario Rapid integration scenario Sustainable policy scenario
ASTRA (ASTRA, 2000)	ASTRA system dynamics model	2000–2026	Improving safety and emissions package Increased fuel tax and reduction of labour cost package Balanced fuel tax and reduction of labour cost package Fuel taxation and investments in networks package Integrated policy programme

Project reference	Freight transport model used	Years simulated	Scenarios/policies studied for future years
SCENES (SCENES, 2001)	SCENES model	1995 2020	External scenario plus four transport cost scenarios (constant cost, basic, observed trend and radical)
EXPEDITE (EXPEDITE, 2002)	EXPEDITE meta model	1995 2005 2010 2015 2020	Reference scenario and variants of this for 15 policy measures in freight transport

Source: (de Jong, Gunn, Walker, 2004, pp. 103–124)

These models have the assumption, which is worth noting, that they are to be tools to support bodies of transport policy in decision-making. They can be used to plan and forecast the development of transport systems. According to the authors of scientific publications, some of these have been applied in practice. It is difficult to assess the real usefulness of these models – in the literature there is no information on the subject. It is also interesting that there is a lack of models used at the micro economic level and, above all, in enterprises. One can ask therefore the questions: do these models not provide significant benefits to the business practice? Or does practice not see the predicted benefits?

It may also seem paradoxical that, although these models are systemic in nature and are very complex, many of them concern fragmented problems, subordinated, which has been previously mentioned, to specific problems of decision-making.

The above remarks also apply to models of intermodal transport. Problems for which intermodal transport models are developed relate to a very wide range of issues: from problems of an operational and organizational character (Gambardella *et al.*, 2001, pp. 521–534; Newman, Yano, 2000, pp. 256–270), to problems in the field of investments (e.g. the optimal level of investment) (Pedersen, 2005, p. 171; Kozan, 2000, pp. 235–243) and the market of transport services and transport policy[1]. However, many models relate to the problems associated with optimizing terminal operations and, in particular, marine terminals. At this point it is worth making the following remark: interest in the problems of modelling in land–sea chains is understandable because these are very interesting and constitute a challenge from a scientific point of view. These chains also have a very large share of global trade, which is also a justification for treating them as an important field for research. On the other hand, they are already well developed, in contrast to the purely land intermodal connections. So we can risk the thesis that there is a need for research on the methods of modelling and optimization of mainly road-rail intermodal transport.

A second remark relates to the structure of a model. The model should have a clearly defined goal and a problem that is to be solved with the use of this model. It is essential, if it is to be an optimization model, to determine the optimization criterion. The criterion may be the total cost of transport (Beuthe *et al.*, pp. 253–266; Sahin *et al.*, 2009, pp. 1–11).

[1] For example, a model LAMBIT allowed assessment of the impact of the fuel price increase on intermodal transport services market (Macharis *et al.*, 2010, pp. 550–561).

A review of the literature, concerning the issues of optimization and modelling of intermodal transport, reveals a lack of models covering entire transport processes as well as those in which the criteria would have an economic character (Rizzoli, Fornara, Gambardella, 2002, pp. 57–71).

Existing models are in fact designed to solve specific problems encountered in different places of the intermodal chain. There are models that are systemic in nature (Flodén, 2007; Groothedde, Ruijgrok, Tavasszy, 2005, pp. 567–583), but it is difficult to assess their usefulness, because there is no information on their practical application in scientific publications.

It is worth however at this juncture to point out a problem that occurs quite commonly in decision-making models and not only in transportation. In some models a unit cost is used with a fixed value. The unit cost is then used to calculate the total cost. In fact, unit costs change themselves due to many factors. In intermodal transport they result from transportation distance, volume of transported goods, applied technology, terminal investments etc. Simplification in the design of models is of course useful, but not at the cost of properly reflecting the real economic phenomena.

The previously conducted research and developed models indicate seemingly obvious factors of efficiency of the intermodal transport which have been known for years. One factor is transport distance, the impact of which is the greater when a wider range of costs are taken into consideration, and, above all, if external costs are taken into account (Sahin *et al.*, 2014. p. 10). One of the best known models is that developed by Milan Janic (2007, pp. 33–44; 2008, pp. 1326–1339). The results of simulation, carried with the use of this model, reveal that intermodal transport is effective (competitive versus road transport) on long distances. Yet, in practice we have evidence that this transport is used also on shorter distances. So the questions arises: what are other factors that influence its economical effectiveness?

The desirability of conducting research in the field of modelling of intermodal transport occurs when a problem we want to solve is important and the model can help to solve this problem. With this in mind one should analyse a system of intermodal transport in terms of identified research problems.

The cost structure is essential to identify important factors in the efficiency of intermodal transport. Data concerning costs given in the scientific literature are not unequivocal. The structure of total costs, which includes costs of haulage, transhipment and transport on the main line (e.g. rail) are given at different levels by different authors (Wronka, 2008, p. 114; Dărăbanț, Ștefănescu, Crișan, 2012, pp. 81–87; Stokłosa *et al.*, 2014; Liljestrand, 2010). The reason for this is that these are probably average data. In fact, the economical efficiency of intermodal links and the costs structure depends on many factors, among others the applied technology.

In Europe there are developed markets in intermodal connections (Germany, Benelux, Austria, Switzerland, and Italy) and markets at an early stage of development. The markets have different parameters for the processes of intermodal transport, which influence their effectiveness. As a result there are variety of obstacles to improving their competitiveness against road transport. In case of the developed markets the struggle with congestion and the improvement of network throughput are important. In developing markets the factors which matter are the profitability

of individual connections and effectiveness of investment in new networks of terminals. In others a more complex approach is needed in the case of intermodal connections linking the two discussed transport markets, e.g. the countries of Eastern and Western Europe.

Conclusions

Intermodal transport scientific studies using models should bring real effect for the final recipients of these research. In the case of intermodal transport it can be assumed that these are the intermodal transport operators and the institutions of transport policy.

On the basis of the analysis made by the authors, it can be concluded that previously developed models of transport systems and processes may not always constitute a useful research tool. There are significant limitations of model-based methods when applied to the assessment of economic phenomena in transport, including intermodal transport, or in decision-making processes. There are considerable gaps in the knowledge concerning complex intermodal systems, particularly concerning factors affecting the economic efficiency of these systems. The presented scientific models, despite the fact that they should enable the analysis of complex business process relationships, are often of a fragmentary nature. There are no models that are really systemic.

Modelling of intermodal transport processes should start with the analysis of the problems associated with this form of transport, and primarily the widely understood efficiency factors are relevant. This analysis can be used as a basis for the formulation of recommendations for the creation of models (or possibly a single universal model). The authors are aware that the creation of a universal model of the intermodal transport efficiency would be a great challenge. However, there is the rational assumption that this task is feasible for specific transport directions or transport corridors. There are also possibilities to create dedicated models for homogeneous intermodal transport networks.

A major challenge for research are heterogeneous transport networks, i.e. covering the points of origin and destination characterized by different economic environments, micro-scale and macro-scale. This type of situation is encountered in internally diversified developing countries and between the countries that are on the two opposite poles of economic development.

There is a need for a stronger relationship between theoretical research models and economic practice, in the sense that models should be used to solve relevant problems, and that these should reflect actual economic processes and phenomena. Relevant economic efficiency issues and decision-making areas identified by the authors in intermodal transport systems include:

– transport technology choice (intermodal transport horizontal and vertical transhipment technologies, rail and road haulage technologies),
– intermodal terminals design (size, infrastructure, equipment, location, organisation),

– the profitability of transport connections (existing and proposed),
– optimisation of intermodal transport network (m.in. eliminate "bottlenecks" and "white spots").

The proposed directional research objectives include:

– impact of economies of scale (longer trains, bigger terminals, value-added logistics services, longer and heavier road vehicles, networks expansion, etc.),
– system flexibility (the lack of balance, changes in demand, flexible loading units, versatile terminals, etc.),
– cost-effectiveness of the system in micro-scale (logistic operator) and macro-scale (EU, Member States), taking into account the variability of the efficiency factors (EU sustainable transport strategy, support for the infrastructure development, subsidies for the new connections, alliances/shareholdings/monopolies in logistics chains, globalization).

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Corresponding authors

Dariusz Milewski can be contacted at: dmilewski1967@gmail.com
Bogusz Wiśnicki can be contacted at: b.wisnicki@am.szczecin.pl

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Blanka Tundys[a)], Andrzej Rzeczycki[b)]

a) Department of Logistics, Faculty of Management and Economics of Services, University of Szczecin
b) Department of Logistics, Faculty of Management and Economics of Services, University of Szczecin

THE EFFECTIVENESS OF USING THE LOGISTICS DECISION GAMES IN THE EDUCATIONAL PROCESS – THE ANALYSIS OF THE EMPIRICAL STUDIES

Abstract

The development of information technology has contributed to changes in the approach to the learning process. Increasingly, in the framework of teaching is using modern methods of activating education. These can include: hardware simulators, educational decision games, and simulation. They can be classified into the so-called group: serious games. Numerous studies show the effectiveness of this type of solution, not only in the teaching process, as the element is diversified activities, but also in developing and improving social competence, skills and knowledge of the participant. The submitted considerations present the effectiveness of this kind of technology in the educational process of students of Logistics the University of Szczecin. The aim is not only to acquire the skills and taking quick decisions by using the environment and IT tools, but also to check the effectiveness of this type of solution, in terms of changes to knowledge skills and social competence. In addition, the teachers during the classes, carry out the surveys (input at the semester beginning and output at the end of the semester), whose purpose is to indicate the extent to which, during a 15-hour module are changed competence of students.

Keywords: learning methods, serious games, logistics, decision games, analysis

Introduction

Computers have become an essential tool of work in many areas of the economy. The ability to use it is undoubtedly an attribute and a valuable skill. In the field of logistics and supply chain management, the use of advanced technology supports strategic decision-making, planning and execution processes. Logistics is largely based on the ability to use dedicated programs to support the logistics processes and business management. However, undoubtedly the use of public or dedicated programs and games in the teaching process helps support the learning process, to stimulate creative thinking and non-standard decisions, based on information of the created by the computer system. It is recognized that the use of the didactic process of the computer concentrates on the possibilities of all teaching media (Siemieniecki, 1997). It is a multifunctional tool that interacts with many receptors, allowing for the acquisition of knowledge with many senses. The computer can act as a teacher to be a participant of fun, a tool to work. It is becoming increasingly common practice to create the entire didactic process from a given object in the game formula. This is called gamification process. Gamification refers to the application of game dynamics, mechanics, and frameworks into non-game settings (Stott, Neustaedter, 2013). Computer games (simulation, strategy, serious) contribute to increasing the attractiveness of teaching as well as increase the involvement of students in the learning process. Use them in the teaching process (higher education) may contribute to the development of managerial competence. In principle, it is indicated that the use of games is effective where conventional methods do not meet their job, or they are too expensive (Kamiński, 2015). In terms of logistics management and supply chain management, it can transfer and mapping (visualization) reality often complex relationships between the cells. Transfer processes to the virtual reality allows the development of practical managerial skills, relating to the implementation of processes and relationship management with stakeholders in a holistic approach. This approach, and the possibilities offered by the game, players can easily move into the field of professional practice. Decision making is a part of everyday life. Some decisions have big importance while others are quite simple. Each decision in the supply chain can be supported by just games.

1. Developing and implementing of games in the area of the supply chain in higher education

Research shows that the usefulness of games in the education process is high, also in academic education (Łączyński, 2011), and may be more effective than the standard method of teaching (Kapp, 2012). Analyzing the literature on the subject can be demonstrated that: gamification can help enrich educational experiences in a way that students will recognize and respond to (Deterding, 2012).

In the literature we can find several types of gaming concepts or games, which are used in the teaching process (Jackson, 2016):

– gamification involves the use of game-game design elements and mechanisms in non-game context. Generally, this includes elements such as "rewards", leader boards, badges, levels, trophies, among others,
– game-based learning: the use of actual games in the classroom to reinforce course concepts and enhance the learning and teaching experience (Wiggins, 2016),
– serious games: serious games are games designed for a specific purpose related to training, not just for fun. They posses all game elements, they look like games, but their objective is to achieve something that is predetermined. There is computer application, for which the original intention is to combine with consistency, both serious aspects such as non-exhaustive and non-exclusive, teaching, learning, communication, or the information, with playful springs from the video game (Alvarez, Djaouti, 2011),
– simulations: simulations are similar to serious games, but they simulate real-world things and their purpose are user training in an environment resembling real life (Kiryakova, Nadezhda, Yordanova, 2014).

The most important effects of using games upon reviewing the available literature, certain underlying dynamics and concepts found in game design are shown to be more consistently successful than others when applied to learning environments. For example could be: freedom to fail, rapid feedback, progression, storytelling (Stott, Neustaedter, 2013). Logistics and supply chain management is an excellent field in which it can use in the process of learning all sorts of games.

2. Aims and research questions

The aim of this paper is to identify how it can use available on the market serious games in teaching process the logistics students. The aim is to present the results of empirical research and applying, to confirm or falsification of research questions presented below.

Taking the viewpoint games using in higher education, we test the following questions:

Rq0: Using decision games in the teaching process is precise and effective learning method, which is to matched set of competencies of student;

Rq1: Games are teaching tool for competency modelling in the conditions of competition and uncertainty, not available in the case of the use of other methods of education;

Rq2: Participation in decision-making games can make students aware of the risks and opportunities flowing from the turbulent environment.

3. Methodology of teaching and evaluation

Teaching with the use of serious games is becoming more and more popular. Therefore, the idea of introducing this type of activity and evaluation of their

effectiveness in the optional courses offered to students of Logistics at the University of Szczecin. The proposed "Logistics decision games" course, in the 15-hour class cycle in the winter semester of years 15/16 and 16/17, took 77 students (enrolled on their own). As part of the classes, students play the following games:

1) A shortfall – computer game dealing with the supply chain management of passenger cars with broadly expanded aspects of the green supply chain, translating investment decisions in operational, risk management;
2) Beer game – computer game that explains supply chain management in a market uncertainty environment, explains Forrester's effect;
3) TransEDU – computer game that simulates the operational management in a shipping company;
4) INNOV8 2.0 – computer game for supply chain design, process management, strategic management, green and intelligent supply chains, decision making takes place through the use of process modeling;
5) Simulation game – a board game that simulates strategic and operational management problems in a transport service company, business accounting and relationships between functional areas of an enterprise.

Shortfall game was played individually and in groups, INNOV8 and TransEDU were played individually, and the Beer Game and Simulation game only in groups. Each game was discussed with students – the game mechanics and possible strategies were explored, and the students indicated what they learned and what aspects they lacked in the proposed principles.

The aim of the course was to comprehensively evaluate this teaching method as a support to traditional teaching. Therefore, in addition to the opinions of the students, the results of the games and the strategies, time of the games, as well as the changes in the student's way of thinking (judged by the competence test system) were assessed. Namely, students taking part in the course started it by completing the preliminary test related to the subject matter of the games. Students completed the same test, also at the end of all classes so that you could compare the changes in acquiring competences. Of course, students in the same period participated in other activities in the area of logistics and transport, which could also affect their judgment. To minimize this effect, the course has been proposed to the last year students, and therefore of people with already formed views on many logistics issues.

4. Findings

The following paper presents an analysis of differences between preliminary and final competences test of students participating in the course. It has allowed conclusions to be drawn on the method of games selection and how to carry out this type of courses.

In the first question, pointing out the three most important factors to be considered when deciding on the company's logistic activities (e.g., where, how,

and when to produce or sell), students most often indicated demand and profit maximization (fig. 1).

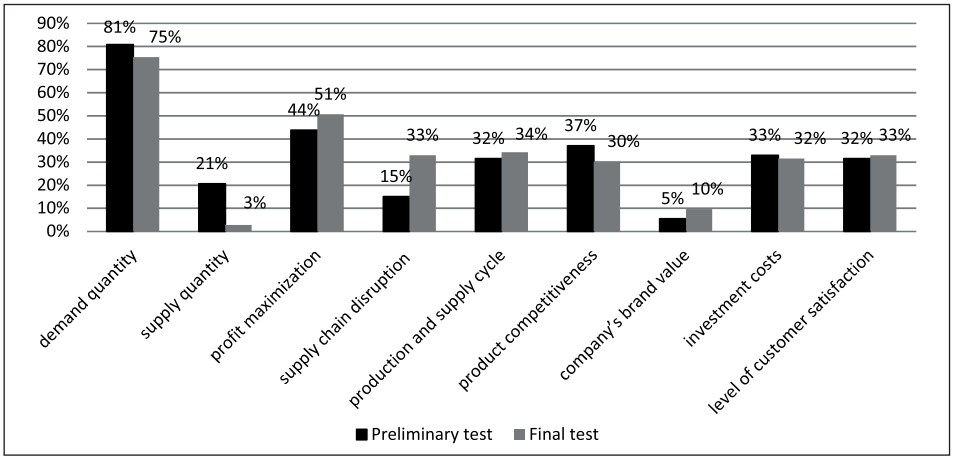

Figure 1. Factors for making decisions about the logistics activities of an enterprise – students survey
Source: (own elaboration)

After the games were still the most common answers, however, the number of students who indicated the size of the demand decreased by 6%, and increased by 7% the number of students indicated a profit maximization. This change is probably due to the fact that in the games played, the students knew precisely the demand constraints and did not pay attention to them, but it was strongly emphasized the need to compete for the profit. These relations are more visible in changes in answers regarding to supply response and supply chain disruptions. Supplies in several games were unlimited so lost sight of students in importance (a decrease of 18%), and there were frequent random disturbances such as delays, strikes, price increases, etc., which led to an increase in student referrals in this area (by 17%).

Under the influence of the games played, the students' views on the hierarchy of strategic supply chain management goals also changed (tab. 1).

Table 1. Changes in hierarchy of strategic supply chain management goals (1 – most important, 8 – least important) – students survey

Factor	Reduction of inventory level	Implementation of environment innovations	Ensuring flow of information in the supply chain	IT support for supply chain	Reduction of global logistics costs	Increasing the flexibility of customer service	Improving product quality	Creating partnerships
1 factor	7%	–1%	0%	–1%	0%	3%	–4%	–3%
2 factor	–1%	4%	4%	–4%	8%	–15%	3%	1%
3 factor	7%	4%	3%	1%	–10%	4%	–5%	–4%
4 factor	1%	0%	0%	1%	3%	3%	–10%	1%
5 factor	–8%	7%	0%	5%	–3%	–8%	1%	5%
6 factor	–1%	10%	–4%	–4%	–5%	0%	5%	–1%
7 factor	–4%	7%	0%	–10%	0%	4%	8%	–5%
8 factor	0%	–30%	–3%	11%	7%	10%	1%	5%

Source: (own elaboration)

Setting the game on the green aspects of the supply chain has raised this goal in the hierarchy, and the presence of standard consumer with fixed requirements has led to a decline in the hierarchy goals for product quality and service flexibility.

Efficiency in raising students' knowledge by using serious games can be assessed by analyzing changes in students responses to the factors that are involved in designing the supply chain (fig. 2). In the pre-test, a significant part of the students did not have an opinion on any of the proposed factors, as they did not know it. Along with the course they learned about these concepts by discussing game rules and strategies. In the final test changes in opinion ranged up to 30% of the test population.

Students also had to indicate which decision areas in the supply chains considered the most important (fig. 3). Just as in previous questions, the direction of change in the answers coincided with the thematic dimension of the game, at the expense of less accented areas.

In the next question, students had to say what the impact on the functioning of the supply chain have the indicated results (tab. 2). It should be added, that these effects (except Forrester's effect) were not a direct topic discussed in the games, but their impact was felt during the game. The lack of attention of the teachers to these aspects caused, that the students don't notice clearly the role of these effects in supply chain management. This points to the need for detailed discussion of games. Self-directed learning through games may be insufficient.

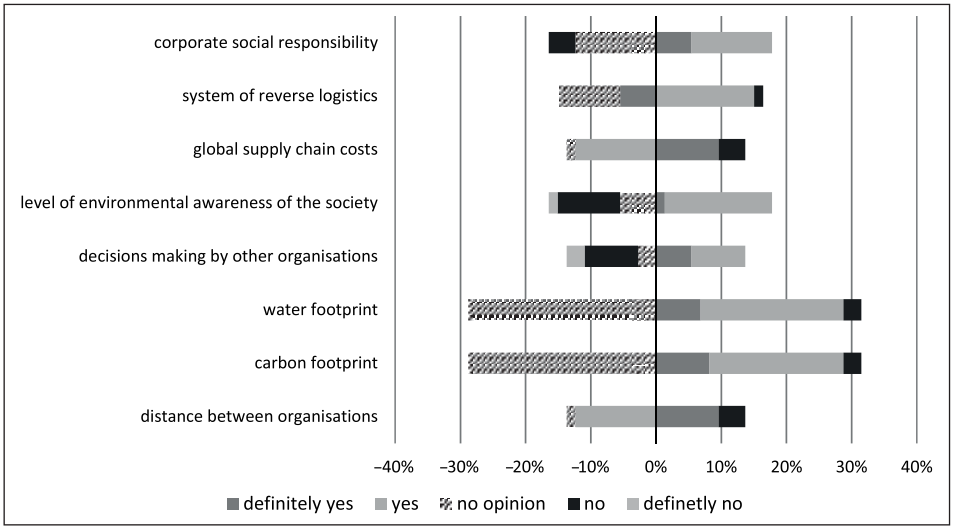

Figure 2. Changes in students' opinion on factors considered in the design of supply chains
Source: (own elaboration)

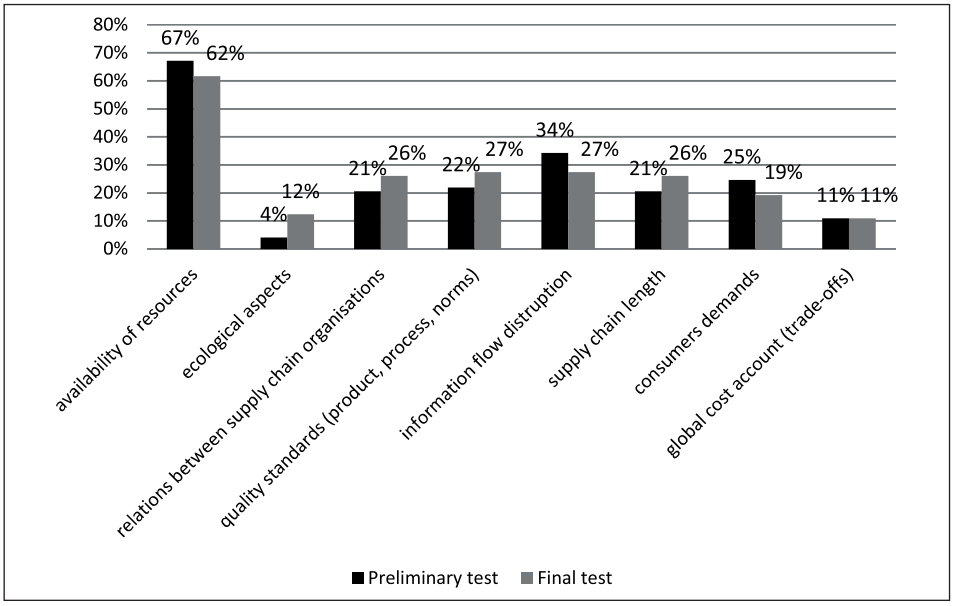

Figure 3. The most important decision-making areas, where you can encounter problems regarding the implementation of logistics tasks in the supply chain – student survey
Source: (own elaboration)

Table 2. The matrix of the student's opinions changes about the impact of the economic effects on the functioning of the supply chain

Response	Globalization effect	Economies of scale	Forrester's effect	Experience effect	Synergy effect
Very bad	0%	–1%	11%	–1%	0%
Bad	0%	1%	–1%	0%	1%
Neutral	5%	–7%	–1%	5%	–8%
Good	10%	14%	–4%	0%	8%
Very good	–15%	–5%	–1%	–4%	1%

Source: (own elaboration)

The students also pointed out how they build strategy in games by answering questions about the acceptance of certain activities (tab. 3), the weight of particular aspects of sustainable development (tab. 4) and the indicators they paid particular attention to (tab. 5).

Table 3. The matrix of the student's opinions changes about the level of acceptance of selected actions in the functioning of the supply chains

Response	Higher transport costs by using ecological means of transportation	Higher storage costs by using modern green logistics infrastructure	Higher production costs by using environmental requirements	Increasing the cost of the product but with the implementation of environmental aspects	Increase in logistics costs, while increasing customer satisfaction	Increase global logistics costs but taking into account environmental aspects in the chain	Increase global logistics costs associated with supply chain lengthening
1 – I don't accept	3%	–3%	0%	0%	4%	3%	–7%
2	–11%	1%	4%	3%	–3%	–7%	–8%
3	–4%	–21%	–18%	–8%	–8%	–3%	4%
4	8%	15%	7%	–3%	–10%	3%	11%
5 – I accept totally	4%	7%	7%	8%	16%	4%	1%

Source: (own elaboration)

In the majority of cases, the games played increased the acceptance of pro-ecological activities and increased the level of customer satisfaction. Only the social aspects have declined in importance as they were not part of the game being run.

It should be noted that the soft aspects of economics, such as interpersonal relationships, behavioral psychology, conflict resolution, etc. are difficult to discuss in traditional teaching. In this area one can especially consider the use of games, especially board games and group games based on cooperation as well as competition.

Table 4. The matrix of the student's opinions changes about the weight of particular aspects of sustainable development

Response	Ecological	Social	Economic
Never	0%	0%	0%
Rarely	–5%	–4%	0%
Sometimes	–10%	11%	1%
Often	7%	4%	–5%
Always	8%	–11%	4%

Source: (own elaboration)

Table 5. The matrix of the student's opinions changes about the measures taken into account in supply chain management

Factor	Cost per unit of production	Number of products sold	Environmental performance of the investment	Communication speed	Volume of stocks	Amount of waste generated	Price of materials/ semi-finished products	Price of the final process
1 factor	–8%	–12%	8%	0%	8%	0%	–4%	8%
2 factor	–4%	0%	0%	0%	8%	16%	4%	–24%
3 factor	4%	20%	8%	–4%	–8%	4%	–20%	–4%
4 factor	–8%	8%	–4%	8%	–12%	8%	4%	–4%
5 factor	–8%	–12%	0%	8%	–8%	–8%	12%	16%
6 factor	12%	–4%	–16%	–12%	16%	0%	–4%	8%
7 factor	12%	4%	–12%	–8%	0%	0%	4%	0%
8 factor	0%	–4%	16%	8%	–4%	–24%	4%	0%

Source: (own elaboration)

Some inaccuracies in relation to gameplay occurred when selecting supply chain management parameters. Surprisingly, in particular, the importance of the quantity of products sold was falling. In the games students set their own prices, so they didn't have to take into account the amount of costs, compensating that for the customer by higher level of service. However, one of the monitored results has been always a profit, which directly depends on the quantity of products sold. This inaccuracy confirms the importance of the role of the coach in discussing the games and his experience in running them.

Conclusions

Decision-making games effectively support the problems explanation of this scientific specialty. Introducing competitive rivalry between players strengthened student involvement in the course and highlighted the potential conflicts that occur within the supply chain. The unpredictability of certain situations in the game effectively changes the student's original strategies, paying attention to risk taking

and prevention issues – this is evident in particular during subsequent rounds or competitions.

Achieving the intended learning outcomes is largely dependent on a well-prepared summary by the coach, the game is only a tool to explain and visualize the mechanisms of the functioning of the presented issues. The student is unable to capture all the shortcomings of the simulated problem alone. It should be remembered that game, like a model is a simplified environment, and the task of the coach is to point out these shortcomings and simplifications.

Thus, when designing a course based solely on serious games, it is best to choose a game or set of games in such a way as to provide a broad perspective on the subject matter (so as not to distort the way the student thinks about the whole subject through the prism of one problem).

Board games allow you to shape competences other than computer games. The best didactic effects give the parallel play of both forms of play. Board games. Especially support simulations of negotiation behavior, interpersonal interactions in companies, conflict resolution. Computer games simulate the randomness of the events, increase the analytical skills of participants and allow the gameplay with a large number of variables included.

After analyzing the results of the research and responding to research questions, it should be pointed out that it has been proven that the use of games in decision-making learning processes is a very precise tool for shaping students' competencies. By using this tool you can shape and enhance the student's competency level precisely while identifying its competence and knowledge gaps, while moderately moderating the game's new shape. It can definitely identify the benefits of games using in the learning process that reflect the real economic situation as well as the unexpected situations that may occur in the economy. In this respect, decision-making games have a definite advantage over other teaching tools. Students can react in real time and adapt their decisions to the situation. The occurrence of unforeseen situations makes it possible to raise awareness and react simultaneously. It also makes students aware that the surroundings are turbulent and may unexpectedly change. In conclusion, it should be pointed out that the use of decision-making games in the didactic process is definitely a useful tool for developing new skills that cannot be molded using standard teaching techniques and tools.

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Corresponding authors

Blanka Tundys can be contacted at: blanka.tundys@usz.edu.pl
Andrzej Rzeczycki can be contacted at: andrzej.rzeczycki@wzieu.pl

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Anna Brdulak

Institute of Logistics, WSB University in Wrocław

THE ROLE OF LOCAL AUTHORITIES IN THE IMPLEMENTATION OF THE SUSTAINABLE STRATEGY

Abstract

To provide a good level of the quality of life of the city inhabitants, it is indispensable to follow sustainable development strategy, allowing to create social capital. This is important especially for local authorities, which should govern society by cooperating with them. Therefore, the main purpose of the article is to present implementation process and its conditions of the sustainable development strategy within the structures of local government units in Poland. Analysis is based on the authoress' own qualitative research conducted in four voivodships in the Southern of Poland.

Keywords: sustainable development, sustainable development strategy, local government unit, social capital, quality of life

Introduction

Sustainable development is, apart from knowledge- and innovation-based economic growth and fostering a high-employment economy, one of the three priorities of the Europe 2020 strategy, which was formulated by the European Union, with a focus on delivering economic growth in EU member states. The strategy puts forward seven flagship initiatives to boost economic growth and employment. The flagship initiatives include, under specific priority themes:

1) A digital agenda for Europe;
2) Innovation Union;
3) Youth on the move under the priority: Smart growth;
4) Resource efficient Europe;
5) An industrial policy for the globalisation era under the priority: Sustainable growth;

6) An agenda for new skills and jobs;
7) European platform against poverty under the priority: Inclusive growth.

EU recommendations are reflected in the guidelines set forth in development documents, drawn up at a national level. They include i.a. Long-term National Development Strategy 2030 (DSRK 2030) and National Spatial Development Concept (prepared 20 years in advance).

The aforementioned two documents provide a framework for the model created in order to meet the expectations of the European Union in terms of coherence of strategic documents developed on a national level by EU member states.

Further on, the following documents should be listed:

1) Medium-term National Development Strategy 2020 (ŚSRK, a 10-year horizon);
2) The European programme document Europe 2020;
3) Nine Sector Strategies, integrated with ŚSRK;
4) The National Reform Programme which is a basic tool to accomplish the obligations and guidelines identified in the Europe 2020 Strategy, adopted at the level of EU member states;
5) Partnership Agreement (UP) adopted by the Council of Ministers on 8 January 2014 along with the schedule.

The aforementioned documents, being the result of a new way of managing the development of the state, provide substantial evidence of the weight that the state attaches to fostering smart and sustainable economic development. Sustainable development is conducive to building social capital, which provides the foundations for the establishment of smart cities.

In spite of their diverse subject matter, the documents are linked by objectives set by Poland, such as increased competitiveness of the Polish economy, knowledge- and innovation-based economic growth, achievement of regional cohesion and solidarity, growth of Poland's social capital, improvement and development of infrastructure, as well as energy and environmental security.

These goals cannot be achieved without taking into account the principles of sustainable development in the strategic documents that are being drafted. Hence, the tenets of the concept can be identified in each of the aforementioned strategies.

In order to underline the key importance of the sustainable development idea at a national level, the principles of the idea were written down in Article 5 of the Constitution of the Republic of Poland, and thus gained constitutional rank.

The paper describes the approach of local authorities towards the sustainable strategy against the background of building social capital. The author refers to qualitative interviews which she conducted with interviewees in management positions in municipalities (gmina) and districts (powiat), in the following four voivodeships (województwo) in southern Poland: Lesser Poland (małopolskie), Silesia (śląskie), Opole (opolskie) and Lower Silesia (dolnośląskie).

1. Perception of the sustainable development concept at a local level

Local authorities, being local government units playing the role of active hosts in specific territories, are responsible for contributing to the socio-economic development through their actions (Kłosiewicz-Górecka, Słomińska, 2001).

According to Ryszard Brol, municipalities and districts constitute an integral part of a larger whole. On the one hand, they profit from resources available in other territories; on the other, they make their own resources available to their environment, accept external funds and transfer their own funds to other areas (Brol, 1998). In this context, it is difficult to define in detail the field of their socio-economic or spatial development.

Actually, development referring to specific management levels can be referred to if consistent and harmonious actions taken both by local authorities, inhabitants of the municipalities and districts, and by other entities are aimed at creating new and improving the existing functional properties of local government units, creating new, favourable conditions for the development of local economy and ensuring spatial order (Brol, 1998).

The duties of municipalities and districts arise from the Local Government Act of 8 March 1990 and from the Act of 5 June 1998 on the local government of the district.

Both the quality and method of execution and use of sustainable development elements in the actions taken are conditional first of all upon the approach of local authorities and the employees of the municipal council. The local government unit may have a modest budget, but still be well perceived by the inhabitants, and the actions taken by the unit may be conducive to the development of the territory falling within its remit i.a. by attracting investments and improving the quality of life of the local community in various areas.

Apart from statutory tasks, local authorities are under an obligation to implement sustainable development, which is elaborated on in detail in Agenda 21. The sustainable development idea referred to in the document should be interpreted in a cascade-like manner. First of all, it ought to comprise actions in specific countries, next regions followed by districts and finally municipalities, the last tier of national organization. Sustainable development should be expressed in the Government Environmental Policy, adopted in 1991 in Poland, in local agendas and municipal agendas. In accordance with relevant guidelines, local authorities are the main executive bodies owing to their decision-making capacity in terms of pursuing the local development policy.

Owing to the functioning of local authorities at a local level, they constitute a kind of standard for the local community and organizations operating within the municipality. Through their activities, local authorities take on the responsibility for education and motivating the society to take steps aimed at building social capital, protecting the environment and development in a broad sense, not only personal, but also economic, in their territory. Against this background, when

implementing the sustainable development idea, the local government ought to take into consideration three crucial areas: economic, environmental and social.

In particular when it comes to the social area, in order to offer the local community a high quality of life, the local government should place special emphasis on the integral development or elimination (if adverse) of all areas contributing to this quality: health, social conditions, employment, income poverty, education, family, active participation in the life of the community and society, housing, transport and communications, leisure time and culture, life satisfaction, safety and the environment[1].

It goes without saying that the quality of the steps taken by the local governments is affected by the existence of the development strategy intended to structure and render coherent the programmes in various subject matter areas, drafted by municipalities or districts. Providing foundations for the activity of local governments, the strategy is expected to capture a long-term planning perspective and at the same time to provide a set of rules of conduct for local authorities, a set of determined objectives and ways to achieve them, tailored to the situation of the more immediate and more distant environment. The strategy should take account of all socio-economic phenomena within the remit of the local government, thus phenomena that the local government can influence and is responsible for (Gorzelak, Jałowiecki, 2000).

2. Stakeholders and their impact on sustainable strategy in local government units

Through performance of their own tasks and tasks commissioned by government administration bodies, municipalities and districts strive for the satisfaction of the stakeholders' needs and expectations.

The notion "stakeholder" defines both an individual and a group in an organization's internal and external environment; the individual and group have indirect or direct impact on the way the organization functions. Hence, stakeholders include employees, clients, customers, NGOs or social partners. An organization which adheres to the principles of sustainable development is held responsible before the stakeholders for the outcome of its actions, and at the same time the organization attempts to engage the stakeholders in a debate on various issues related to its functioning.

In the context of enterprises, Christopher Laszlo defines a stakeholder group as groups and single entities which are directly or indirectly related to the organization and have "their intentional or unintentional input in the company's potential to generate assets" (Laszlo, 2008).

[1] The first European Quality of Life Survey was conducted in 2003 by the European Foundation for the Improvement of Living and Working Conditions, established by the European Commission. 12 issues related to life included in the survey integrate three types of sustainable development governance.

Professor Maria Romanowska looks at the notion of a stakeholder from a broader perspective. She adds a description of stakeholder relations with the organization to Laszlo's definition. In her opinion, stakeholders are groups or individuals interested in the operation of an enterprise and can at the same time formulate specific expectations towards the enterprise. Stakeholders include both entities providing an enterprise with specific resources and those relying on an organization's resources, risk-bearing entities and entities shaping the level of risk, as well as entities in a relationship with the enterprise, be it compulsory or voluntary. Thus, stakeholders comprise vendors and suppliers, customers, banks, insurers, trade unions, local authorities, social and political organizations, and several other entities (Romanowska, 2004).

Adriana Paliwoda-Matiolańska divides stakeholders into groups owing to the nature of the relationship existing between them and the organization. As Paliwoda-Matiolańska sees it, three stakeholder groups can be distinguished:

– consubstantial stakeholders – those who contribute to the development of the enterprise owing to their personal input: work, expertise, competencies and capital. They consist of employees, shareholders and owners, as well as the management team. The relations between the stakeholders in question and the company are consubstantial in their nature, which means that without them business as such lacks any *raison d'être*,
– contractual stakeholders – those who originate directly from business operations. This group is made up of company customers and clients, business partners, vendors, suppliers and competitors. Their relations with the organization are based on some kind of official contract,
– contextual stakeholders – those who play a key part in the businesses earning their reputation and approval of how they operate and what they do, as well as those who defend public goods and demonstrate care for public goods such as peace, security, freedom, justice or the environment. This group factors in various communities, from the local community, regional community, to the national or even global community. Besides, this group also consists of all kinds of social and government bodies, which have a contextual relationship with the enterprise (Paliwoda-Matiolańska, 2009).

The quoted characteristics of stakeholder groups of enterprises may be referred to stakeholders of local authorities. It should be highlighted though that divergences between the objectives of public organizations and the objectives of business organizations will affect the composition of the stakeholder group which, in the case of public organizations, additionally consists of taxpayers, state authorities, interest groups, as well as other public organizations. Therefore, it can be stated that accomplishment of objectives seems to be more complex for public organizations than for commercial organizations (Kowalik, 2011).

Figure 1 exemplifies the division of stakeholders based on the strategy of one of the examined local government units.

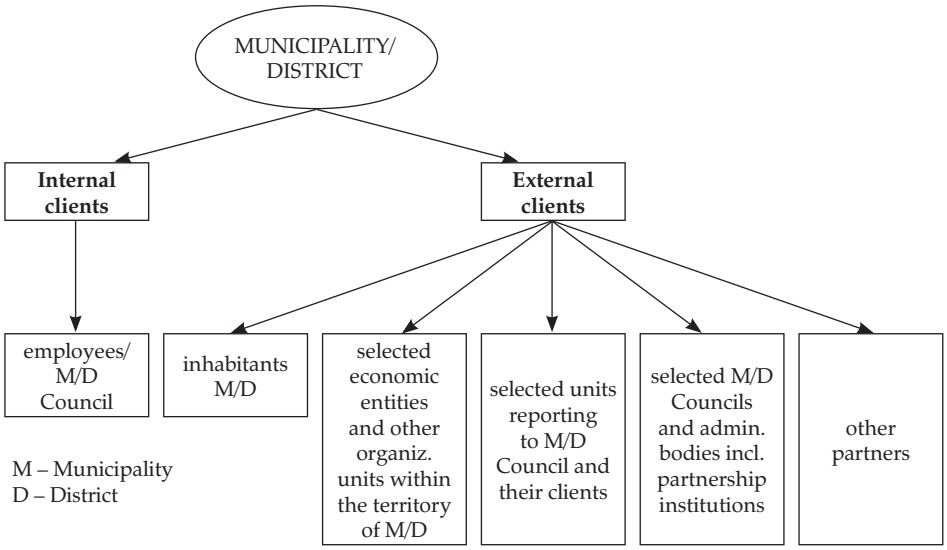

Figure 1. Stakeholders of local authorities (municipalities and districts)
Source: (author's own study based on the strategy of Dzierżoniów municipality)

Local authorities ought to take a closer look at their stakeholders. There are some questions that they should ask themselves: who can be found in their environment, are they persons or institutions, are there any characteristics that they have in common, what are their expectations from the organization, to what extent can the organization meet them, is it a good idea to engage the stakeholders in the functioning of the organization, if so, how? An insight into the aforementioned issues has a fundamental impact on the manner relationships are built with interest groups and is very helpful in the context of building the organization's development strategy further on (Brdulak, Brdulak, 2017).

The stakeholders of municipalities and/or districts can be split into two basic categories: internal clients and external ones. The first group includes the employees of municipal or district councils. Their expectations are predominantly connected with the following issues:

– job security,
– a positive atmosphere at work,
– opportunities for development, knowledge acquisition and promotion,
– satisfactory remuneration,
– job satisfaction.

The external stakeholder group is somewhat broader and significantly affects the formulation of the organization's strategy. External stakeholders will always lend considerable weight to such issues as:

– compliance with applicable legal rules as regards public law liabilities,
– level of cooperation to boost local growth,
– the extent to which action is taken to foster structural change,
– ethical conduct,

– integrity and reliability of the organization,
– having environmental agendas in place,
– secure operation, additionally taking account of the needs of the society,
– engagement in scientific, sports and cultural activities by e.g. granting patronage to specific events,
– transparency in public spending,
– clear, current and accessible information about actions taken (Walczak, 2010).

The strategy of the local government should foster undertakings that the authorities are capable of handling and taking responsibility for. Hence, the strategy should avoid objectives whose accomplishment hinges on a decision or conduct of a different, independent entity, such as an international organization, government, other voivodeships, municipalities, enterprises or private investors. The strategy needs to capture the overarching positive and negative stimuli from the environment (Gorzelak, Kozak, 2012).

The fundamental objective of the strategy pursued by local authorities, directly relating to Article 7 of the Local Government Act and Article 4 of the Act on the local government of the district is about improvement of the quality of life of the inhabitants, at the same time with respect for the natural environment. A question arises though to what extent this objective should be taken into consideration in the development strategy of the municipality or district. As the expression "improvement of the quality of life" requires to be elaborated on and thus is not subject to operationalization, the objective *per se* should not constitute the key objective or should be particularized both in terms of the overarching objective and detailed goals. In this case, measures provided for in the quality-of-life index, developed in 2005 by "The Economist", are worth considering. They include material well-being – per capita GDP in US dollars whilst maintaining the purchasing power parity, family relations defined by the divorce rate (per 1000 people), job security expressed as unemployment rate (%) or community life (church attendance or trade-union membership) (The Economist Intelligence Unit's quality-of-life index, 2005).

3. Essential challenges faced by local government units, related to sustainable strategy implementation

Practically, local authorities differ in their approach towards the application of the principles of sustainable development. On the one hand, the authorities are perfectly aware of the obligations ahead of them, on the other, they excuse lack of coherence in the actions taken or not taking action at all with financial limitations. Scarce funds, necessary to accomplish the annual plan, were indicated by all respondents taking part in the survey conducted by the author.

There is a rationale behind this argument. Local communities are currently the key service provider in a welfare state. The tasks that they are responsible for, such as education of children and youth, creating the elderly care system,

the payment of benefits and allowances or operating the labour market policy are multifarious, complex and extremely costly (Forum Od-nowa, 2013).

It can be inferred from interviews with persons in management positions in municipalities and districts that the number of duties and responsibilities assigned to local authorities is increasing, which is not reflected in the granted subsidies. This may result in increasingly poorer quality of task performance and less and less care for the implementation of the sustainable development idea in the region in spite of commitment and eagerness of local authorities.

Moreover, there is a risk that in time perspective smaller local government units, acting on their own, will be incapable of handling more complex and more expensive public tasks related to the aging society. This issue, just like depopulation of municipalities and districts, affects more and more units.

According to the 2011 report of the Ministry of Administration and Digitization, *Evaluation of the Situation of Local Authorities* (*Ocena sytuacji samorządów lokalnych*, 2011), the average Polish municipality has a population slightly above 15 thousand. Even countries with a lower population density than Poland (e.g. Finland or Norway) have municipalities of similar sizes. In sparsely populated Sweden, the average municipality has 32.5 thousand inhabitants. In Denmark, which is similar to Poland in terms of density, municipalities have an average population of almost 57 thousand.

A tendency can be seen all over Europe to consolidate local authorities at a municipal level. When it comes to Poland, diverse sizes of the municipalities raise doubt, while simultaneously local government units are not categorized. Regardless of whether the municipality is inhabited by 100 thousand or by 2 thousand people, the scope of tasks of a local government unit (in accordance with the national acts of law) is the same although the specificity of the tasks or their costs are completely different. Local public transport may serve as an example. In accordance with the national acts of law, this is a municipal task. Actually, the task is performed in the largest local government units only (usually those with a population above 50 thousand).

Against this background, the alternative to the merging of municipalities, which are highly dispersed, is inter-municipality or inter-district collaboration. Legal limitations are another serious barrier. As an example, in accordance with the national acts of law, each municipality must have its own public library. As the author sees it, the regulation seems to be irrational from the vantage point of both the costs incurred by the municipality and putting the facility to good use by the potential readers. A better idea might be to impose on the municipality an obligation to offer library services, performed in cooperation with the neighbouring municipalities[2].

Being close to the local community, knowing the community's needs and expectations, and being aware of local circumstances, local authorities make plans for the actions to be taken. One of the most serious barriers encountered by the authorities while striving for the accomplishment of their development vision, including sustainable development, are multifarious top-down regulations concerning the manner in which the vision is being accomplished, which

[2] The author's own research.

significantly restricts local authorities' rights to make independent choices and decisions in issues that matter to them.

A significant challenge indicated by the interviewees taking part in the survey are legal regulations created by one selected ministry without any communication whatsoever with other ministries, which work on similar projects or their continuation, or a slightly different angle. Lack of information flow can be disastrous, in particular for lowest-tier authorities, municipalities and districts, which are heavily burdened with the costs of purchasing three versions of reporting systems or are required to fill in additional, redundant forms for various state administration institutions.

When drafting legal regulations, the ministries tend to focus on the consolidation of autonomy of the institutions operating under the aegis of local authorities, such as employment offices, public libraries, social welfare centres or schools. In the opinion of the author and the experts representing the NGO consultancy Forum Od-nowa, it would be more efficient to concentrate all issues related to handling the inhabitants' affairs in one multi-functional entity. This would require professional training for the employees of the municipal or district council (starostwo).

The aforementioned challenges, faced by local authorities making an effort to comply with their statutory tasks, are compounded by new ones. National laws undermine a different feature characterizing independence of municipalities and districts, namely the right to delegate and withdraw authorizations within their own structures. This can be evidenced i.a. by the order that the administrative decision notices of the head of the commune (wójt) should be issued by the head of the social welfare centre.

The legal and financial system applicable to local authorities is not conducive to the implementation of principles of sustainable development, either. It is predominantly based on transfers obtained from the state budget. Moreover, most investments have been delivered by local authorities in recent years owing to EU funds. The source of EU subsidies, available in the financial perspective 2007–2013, expired. Grant competitions within the new perspective are only just being drafted.

The strong, procyclical nature of financing local authorities must be emphasized at this point. As a result, financing increases during the economic boom, but local authorities are not protected in any way in the times of the economic downturn. The mechanisms protecting local finances can hardly be pinpointed. Additionally, ministries introduce new mandatory tasks, which require both funds, limited as the budgets are, and restatement of the already set priorities. This makes the situation even more complex.

Government subsidies and subventions continue to focus on the redistribution of funds from the central level, without any willingness to impact the quality of the services. Subsidies to co-finance local authorities' own tasks entail the risk of more spending on the part of the municipality or district, without any visible or palpable benefits for the inhabitants.

This challenge can be exemplified by the situation one of the studied municipalities of the Lesser Poland (małopolskie) voivodeship found itself in. The budget

subsidy specified the funds to develop and implement a digital/electronic[3] document workflow management system. Both implementations require a method to be considered in detail how to "translate" paper documents into their electronic equivalents so as to avoid slowing down current operation of the council, as well as to minimize the risk of errors.

The municipality purchased a relevant IT system. It opted for PUAP, the electronic Platform of Public Administration Services (www.epuap.gov.pl)[4], which delivers the technological infrastructure to providers who, as a consequence, are able to render services to citizens (clients). The management of the municipal council have difficulty understanding the guidelines of the ministry on the method of documentation maintenance and filing. According to the guidelines, the document form must be declared once and for all, and adhered to in the future. As a result, paper and electronic documentation cannot be used in parallel. If the employees choose to work with the electronic form, they will never be able to return to the paper form. This is the first problem encountered by actual users of the electronic document workflow management system.

Another costly and time-consuming challenge, related to the document workflow management system, are the recommendations on the use of qualified electronic signatures. The relevant guidelines are not clear. Although each council employee receives appropriate training on the use of the qualified electronic signature, the actual problem lies in the cooperation with entities such as: courts, regional chambers of auditors (ROI) or local government boards of appeals (SKO). They have their own IT systems, incompatible with the system used by municipalities. As a result, there is no standardized document submission procedure for the entities cooperating with local authorities. Documents must be submitted to courts in person, whereas regional chambers of auditors accept a qualified electronic signature. Undoubtedly, the EU's eIDAS Regulation and the Act on trust services and electronic identification, which is intended to adapt Polish law to eIDAS, constitute a step towards moving Polish administration to the internet. The implementation process is scheduled to be completed by September 2018.

It can be concluded from the aforementioned examples that shortage of implementation tools is the fundamental problem indicated by the municipalities in the digitization process of document workflow, theoretically designed to create standards for document workflow management and to develop new, better forms of customer service. The central IT platform operates on one server, which crashes after a certain number of users is exceeded. There are almost 2500 municipalities in Poland, hence their simultaneous work with the platform is simply not feasible.

[3] The notion "digital workflow" is applicable in the context of the service being used by external clients, whereas "electronic workflow" refers to the personnel of the council.

[4] Ogólnopolska Platforma Teleinformatyczna – the All-Poland ICT Platform – is intended to enable communication between the citizens and public administration bodies in a consistent and standard way. It was built under the ePUAP-WKP project (State Informatization Plan). The service providers are public administration bodies and public institutions (in particular entities performing tasks commissioned by the state).

In the opinion of the representative of the surveyed unit, lack of consistent government policy towards local government units is to blame for ineffective project management; this generates costs and even more red tape.

To sum up, it might be a good idea to quote the opinion of one of the experts taking part in the survey, a management board member of a consultancy cooperating with local authorities i.a. in the area of creating the development strategy. As the interviewee sees it, some part of local authorities is interested in best practices in the context of sustainable development and have a systemic approach towards their application. If a problem arises "you call a colleague of yours from the council and ask: «Well, how do you normally solve this issue?» This method is by no means structured, but it does not mean that it is wrong because exchange of information does take place, after all […]"[5]. In this way, a benchmark base containing solutions to certain problems is obtained.

Conclusions

Strategies of local governments are drafted mainly as local development strategies, and they hardly ever contain a strategy element for the development of the council as such. This does not concern the best councils which have ISO 9001 or ISO 27 000 certification and combine best practices with coherent implementation of the electronic document workflow management project. Hence, it can be stated that the best councils strive to implement a plan for best practices in the context of sustainable development. It is rather difficult though to reach an unambiguous conclusion to what extent the plan has been formalized.

This area continues to be regarded from an operational rather than strategic vantage point. Councils do communicate and share their experiences, but any attempts to work out catalogued solutions that could be deployed in a structured fashion are futile.

The process of fine-tuning best practices is a broader issue. First of all, the extent needs be considered to which management models are attractive for the authorities in charge of an organization. Diverse and frequently conflicting tendencies can be seen in this respect. Internal control could serve as an example – the implementation of this government initiative diverges very much from the assumptions of the Ministry of Finance. The expert has a positive view on the initiative of internal control as such, yet, in practice, it is an unused instrument owing to a large number of statutory requirements that must be complied with.

Lack of a systemic approach towards improving management and negligible support of heads of councils for initiatives appearing in the councils at an executive, secretaries' level are a serious barrier to the development and introduction of sustainable development best practices. As opposed to business, local governments are political bodies. This is reflected in the strategy document that is drafted and implemented by representatives of a specific political party, elected for a four-year term of office. The strategy guidelines ought to capture long-term activities, definitely

[5] An individual interview with an expert conducted in 2013, updated in 2014 and verified in 2017.

going beyond local authorities' term of office. Hence, the strategy should include objectives and tasks enjoying the broadest possible political support, so the successors can continue the policy of their predecessors.

Low management culture, heads of councils involved in a relationship with the world of politics, not having enough time to organize their councils effectively, executive secretaries with not enough clout or considerable financial limitations arising from the inadequate policy of the state – all this prevents best practices in the context of sustainable development from providing a basis for the functioning of local government units.

The implementation of the principles of sustainable development at a local level must be preceded by their appropriate inclusion in strategic objectives of specific plans and agendas. Each planned general and detailed action must draw on the sustainable development idea. The very existence of these documents is insufficient.

It is mandatory that the right sequence of preparing these studies be maintained in order for their content to be coherent (also in legal terms), logical and complementary.

Properly planned strategic actions can be implemented as a result of effective management of a local government unit. This also requires funds to be secured, necessary to perform the tasks for the sake of sustainability.

Practically, the application of the concept hinges primarily upon the perception of sustainable development by local authorities and the degree of commitment to the implementation of sustainable development principles in the organization's structures, as well as upon cooperation of council staff in this respect. Local authorities are responsible for stimulating local growth by creating favourable conditions for sustainable development of economic entities in the relevant territory, for the establishment of new ones and for the enhancement of the level of living of municipality or district inhabitants.

In order to effectively satisfy diverse needs of various stakeholder groups and solve social, economic, environmental or spatial issues with limited funds, the tasks undertaken by the local government must follow a defined and legitimate course, be planned in time and space, and last but not least, their implementation requires a certain amount of financial means. Therefore, local governments are expected to pursue a long-term strategy, coherent both with the intentions of specific units and with the strategies of local governments cooperating with the units, also at higher levels.

This matters to the extent that governments at a local level are not bound by the law to comply with the principles of cohesion; as a result, the quality and legitimacy of the prepared development plans and the attitude towards the strategic building blocks including sustainability is entirely conditional upon local authorities. Thus, management quality and effective implementation of specific tenets of the sustainable development strategy translate into cohesion and durability of the strategy to build a city, where the level of the quality of its inhabitants' life is high.

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Radosław Drozd[a)], Marcin Kisielewski[b)]

a) Faculty of Management and Economics, Gdańsk University of Technology
b) Faculty of Finance and Management, WSB University in Gdańsk

THE USE OF GREEN LOGISTICS ELEMENTS DURING THE CONSTRUCTION OF OFFSHORE VESSELS

Abstract

The article is aimed at the presentation referring to the use of green logistics elements during the construction of the offshore vessels in the following aspects: collection, removal and utilisation of any waste that is harmful for natural environment, elimination of the negative impact that such waste can have on natural environment and the search for the optimal solutions as regards these aspects.

Keywords: green logistics, offshore vessels, collection, removal and utilization

Introduction

In the 21st century the protection of natural environment has become an important element in the functioning of each industrial enterprise (Ficoń, 2009), including shipyards which provide various types of vessels.

Shipyard industry comes as an important and sensitive field of economy which produces modern vessels in which innovative technological solutions are applied (Blaik, 2010).

A significant aspect in the functioning of any shipyard in the world refers to environmental issues which directly or indirectly affect our natural environment (Sołtysik, 2000). Such elements include the following:

a) generation of hazardous waste (e.g. petroleum-derived waste generated during the cleaning of tanks, bilge water from sea-going vessels, containers or canisters with the residues of hazardous substances, oils) and others (e.g. abrasives – copper slag waste),
b) use of paint and emission of harmful volatile organic compounds into atmospheric air,
c) emission of pollutants generated during welding operations into atmospheric air,

d) emission of dust generated during the cleaning of the hulls and steel elements,
e) release of pre-treated waste generated during the cleaning of hulls into the surface water,
f) release of precipitation water into the shipyard basin water,
g) use of water.

The authors of the article focus their attention on the question of green logistics which appears to be an exceptionally significant aspect in the process of constructing offshore vessels and other types of vessels at shipyards. It mainly refers to the issues related to the protection of natural environment, water and soil, but also to the collection, disposal, removal, utilisation of any post-production hazardous waste from vessels, which may be burdensome for the environment.

Green Logistics is a concept ensuring proper delivery of logistic processes in a given enterprise, while limiting the negative impact of functioning of the company on natural environment (Altuntaş, Tuna, 2013).

It results from the drive at limiting the negative impact of the logistic systems on their surroundings. (McKinnon *et al.*, 2010). It also results from the fulfilment of international conventions and the resultant requirements towards governments and corporations (Sbihi, Eglese, 2007).

Green logistics describes all attempts to measure and minimize the ecological impact of logistics activities. This includes all activities of the forward and reverse flows of products, information and services between the point of origin and the point of consumption. It is the aim to create a sustainable company value using a balance of economic and environmental efficiency (Thiell *et al.*, 2011). Green logistics was a concept to characterize logistics systems and approaches that use advanced technology and equipment to minimize environmental damage during operations.

The research carried out by the authors refers to the one-month observation in a Polish shipyard in which five offshore vessels[1] have been constructed (each vessel has been at a different stage of construction).

Because of the restricted character of shipyard data, the authors were able to only present research results and their potential suggestions, without specifying the deadlines or revealing the information on the shipyard the research was conducted in.

The authors divide the research into two parts. The first part of the article presents the analysis of the protection of natural environment during the construction of offshore vessels, and the results of the observations carried out by the authors. The second part of the article refers to the logistics of waste storage during the construction of such vessels and it also includes the observations carried out by the authors.

[1] Offshore vessels are modern vessels of special purpose – they are exploited in exploration industry, oil drilling, mining and processing industry. The standard dimension specifications of such vessels are L=89.20 m, B=19 m, D=9 m. They are equipped with a Diesel Electric drive composed of four power generating sets which provide the total power of 6800 kWe. They are equipped with a dynamic positioning system which allows them to operate even in the toughest weather conditions. Another advantage of such vessels is the contract speed exceeding 14 knots.

1.1. Characteristics of the construction process of an offshore vessel

The construction of an offshore vessel involves the assembly of single constructional elements into one unit which is referred to as a section/block (Plichta, 2013). The whole vessel is composed of such blocks which are assembled in accordance with the relevant construction specifications.

Therefore, in order to ensure the proper course of the assembly process and to meet specific requirements as regards the construction of the particular elements, internal instructions are developed by shipyards on the proper and comprehensive assembly process of the constructed sections. They include, among others, assembly stages and particular operations which must be subsequently performed to meet the constructional requirements defined by the relevant standards (Karpiński, 2004).

The whole process of an offshore vessel construction may be divided into the particular stages during which the following elements are constructed:

1) sub-sections – which include constructional elements and which are provided as a result of the assembly and welding operations. These are the elements which are mounted into the plating panel sections, e.g. web frames, web beams, floor, girders;
2) flat sections – are the constructional elements composed of a plating panels and its stiffening construction. These are the elements of the side shell plating section which may be also used in deck sections;
3) block sections – are the constructional elements of vessels which are composed of several assembled flat sections. They form particular components or parts of the hull, such as wing tanks or double bottom.

1.2. Construction of flat sections

The whole construction process of an offshore vessel can be divided into three main stages which are presented in the figures below:

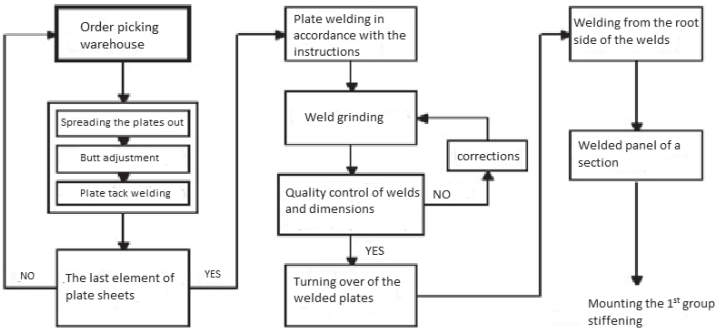

Figure 1. The first stage of the construction of a section for an offshore vessel
Source: (the authors' own study based on the documents provided by the shipyard)

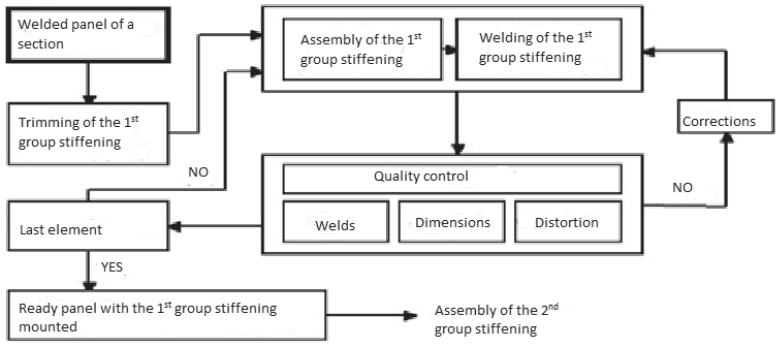

Figure 2. The second stage of the construction of a section for an offshore vessel
Source: (the authors' own study based on the documents provided by the shipyard)

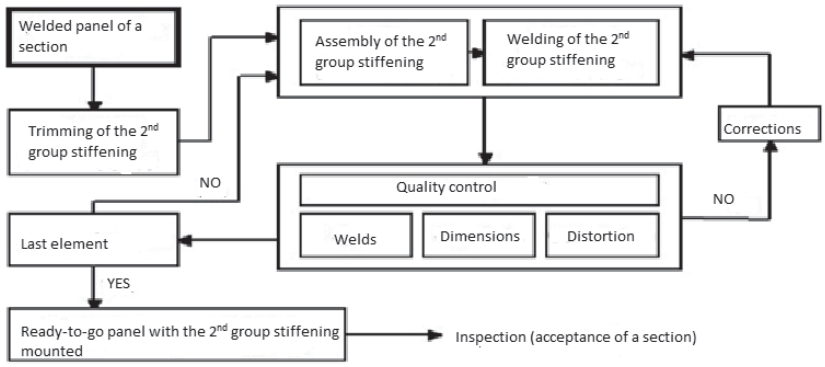

Figure 3. The third stage of the construction of a section for an offshore vessel
Source: (the authors' own study based on the documents provided by the shipyard)

At each stage which has been mentioned above and which is involved in the process of an offshore vessel construction, a considerable threat of natural environment contamination appears through:

a) hazardous waste generated during the process of the assembly of the vessel blocks,
b) exceeded limits of pollutants which are emitted into atmospheric air during the process of welding,
c) exceeded limits of dust emission generated during the cleaning of hulls and steel elements before painting,
d) excessive use of paint and emission of volatile organic compounds into atmospheric air,
e) improper discharge of pre-treated waste generated during the cleaning of hulls into water.

2. Protection of natural environment during the construction of offshore vessels

2.1. Identification of hazardous causes in protection of natural environment (the Ishikawa diagram)

Despite the fact that proper procedures and required standards are respected at the discussed shipyard, it is not always possible to prevent contamination of natural environment and direct exposure of shipyard workers to the consequences of such contamination.

The research carried out by the authors refers to one-month observation (from Monday to Friday – 20 days in total) which has taken place at the discussed shipyard during the production of five offshore vessels (each of them was at a different stage of the construction process). The research aims at the verification of all the observed incorrect factors which substantially affect the organisation of the protection of natural environment.

Considering the confidential nature of the shipyard data related to the type, the marking and the role of the discussed vessels, the authors are only allowed to present the results of their research and their own conclusions.

The research carried out by the authors indicates that the problem with the organisation of the protection of natural environment at the analysed shipyard is generated during the following processes:

a) the assembly of the particular constructional elements into larger sections – welding work,
b) the assembly of the elements included in the equipment of the vessels, e.g. engines (lubricants, oils, fuel, dirt),
c) painting of particular constructional elements of the vessels.

The results of the research indicate that the probability for a dangerous situation to occur and to threaten natural environment at the shipyard are considerably affected by:

a) chemical factors (the use of paints and emission of volatile organic compounds into atmospheric air) – 30% of the cases observed in the analysed vessels during 20-day observation,
b) welding work (emission of pollutants generated during welding operations into atmospheric air) – 25% of the cases observed in the analysed vessels during 20-day observation,
c) industrial dusts (emission of dust generated during the cleaning of hulls and steel elements), emission of dissolvents (volatile organic compounds) during painting – 20% of the cases observed in the analysed vessels during 20-day observation,
d) cleaning of hulls (discharge of pre-treated waste generated during the cleaning of hulls into the surface waters) – 15% of the cases observed in the analysed vessels during 20-day observation,

e) the use of precipitation water (discharge of precipitation water from the cleaning of hulls into the shipyard basin water) – 10% of the cases observed in the analysed vessels during 20-day observation.

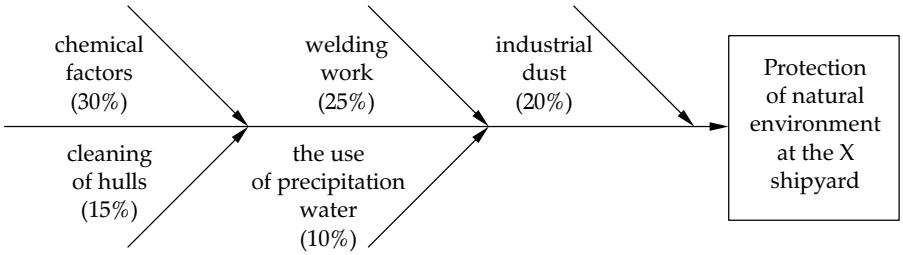

Figure 4. The Ishikawa diagram for the X shipyard, based on the 20-day observation
Source: (the authors' own study)

2.2. Improvement measures

The analysed shipyard should constantly improve its operations as regards the protection of natural environment, with the consideration of its own technical and economic operational conditions. The impact of the shipyard on natural environment should be focused on meeting the requirements which result from the legal regulations and administrative decisions issued for the shipyard.

In order to limit any harmful impact on its natural environment, the shipyard should apply the methods of work and technical measures which shall prevent the emission of pollutants through:

a) compliance with the current legal requirements on natural environment in Poland,
b) limitation of any environmental burdens through the selection and application of environmentally-friendly technologies,
c) improvement in ecological awareness among the shipyard workers,
d) constant improvement of technical and organisational methods which help to decrease the negative impact on natural environment,
e) development of vessel production with the minimal emission of pollutants,
f) efficient use of energy resources,
g) economical and efficient use of material resources,
h) minimisation of generated waste, recycling and segregation of generated waste,
i) application and development of techniques and technologies which prevent the emission of pollutants,
j) consideration of needs related to the protection of natural environment at the stage of planning the production of offshore vessels and during the investment implementation,
k) operations which are aimed at the increase in the knowledge and awareness of shipyard workers and cooperators as regards the protection of natural environment.

Each shipyard should have all the necessary permits and administrative decisions which refer to the exploitation of natural environment, required by the Polish law, namely:

a) permit to emit volatile organic compounds into atmospheric air (paint dissolvents),
b) permit to emit gases or dusts into atmospheric air (dusts generated during the process of cleaning and welding, welding gases, other substances which are released into atmospheric air during technological processes),
c) permit required under the Water Law Act for the intake of ground water,
d) permit required under the Water Law Act for the discharge of industrial waste to the sewerage system,
e) permit required under the Water Law Act for the discharge of precipitation water,
f) permit required under the Water Law Act for the discharge of water used for the cleaning of vessels into the shipyard basin water,
g) permit to generate waste.

3. Reverse logistics in the process of the construction of offshore vessels

3.1. Identification of hazardous causes in waste disposal

Despite the fact that the shipyard has already established its organisational units which are responsible for proper disposal and segregation of waste, the authors of the article have observed that there is a number of problems with the proper disposal of waste on the vessels, such as:

a) waste insulation (mineral wool, polystyrene foam),
b) waste paint (for external and internal use),
c) empty paint and dissolvent canisters,
d) waste oils, lubricants and valves,
e) abrasive waste,
f) scrap steel,
g) waste batteries,
h) waste fluorescent lamps,
i) waste cables and electrical wires,
j) waste pipes and fuel line end-pieces (steel and copper),
k) waste pipes and ventilation line end-pieces (ice water systems),
l) domestic waste from vessels,
ł) wooden reusable packaging, e.g. cable drums and pallets,
m) waste generated during tank cleaning,
n) containers and canisters containing the residues of hazardous substances (used to store paints and dissolvent).

The above-mentioned waste materials may potentially damage and considerably affect natural environment in the area of the analysed shipyard, especially the soil, water and atmospheric air.

Furthermore, the damages to natural environment are caused by improper methods of storage and use of chemical substances and oils (e.g. overfilled containers) and by faulty equipment. The impact of such substances on natural environment depends on their characteristics (e.g. their decomposition time, state of matter, toxicity, concentration), the size of the spillage, efficiency of preventive actions and of the spillage collection.

During their research, the authors have considered the various construction stages of the offshore vessels and that fact has essentially conditioned the observed problems.

The authors of the article present the results of the one-month observation they have performed at the shipyard, during the construction of five offshore vessels in table 1.

Table 1. Improper disposal of waste at the place where offshore vessels are constructed

No.	Improper disposal of waste on the vessels	Marking of five constructed vessels (1–5)
1	waste insulation (mineral wool, polystyrene foam)	2
2	waste paint (for external and internal use)	1
3	empty paint and dissolvent canisters	4
4	waste oils, lubricants and valves	3
5	abrasive waste	1, 4
6	scrap steel	2, 3, 5
7	waste batteries	3, 5
8	waste fluorescent lamps	5
9	waste cables and electrical wires	4, 5
10	waste pipes and fuel line end-pieces (steel and copper)	3, 4, 5
11	waste pipes and ventilation line end-pieces (ice water systems)	2
12	domestic waste from vessels	1, 3
13	wooden reusable packaging, e.g. cable drums and pallets	1, 2, 3
14	waste generated during tank cleaning	2, 5
15	containers and canisters containing the residues of hazardous substances (used to store paints and dissolvents)	5

Source: (the authors' own study based on the research carried out at the analysed X shipyard)

3.2. Improvement measures

Improper disposal of waste during the construction of vessels comes as a serious problem at the discussed X shipyard and it may eventually result in:

a) heavy contamination of soil,
b) heavy contamination of water,

c) heavy contamination of atmospheric air and unfavorable changes in natural environment.

Based on the observation carried out at the shipyard, the authors have noticed that at the initial stage of waste disposal, it is necessary to minimise the quantity of generated waste; then the waste should be segregated and disposed at the place where it has been generated.

According to the authors, in order to eliminate the discussed errors, it is advisable to implement the procedures which would make workers and sub-contractors who operate at the shipyard responsible for the proper waste disposal.

Each shipyard worker and sub-contractor should properly plan and organise their work in order to generate the least amount of waste which should be immediately segregated and disposed at the place where it has been generated.

Proper segregation of all the collected waste should be based on the division into main waste categories, namely: scrap metal, hazardous waste, waste for further segregation, mixed waste.

The above-mentioned people should properly collect and segregate waste, such as scrap metal, cables, wood, plastic, packaging, in order to ensure their most proper recycling later on. The authors have paid their particular attention to the fact that some reusable materials have been contaminated with other waste materials and, in that way, they could not be recycled, for example:

a) mixing hazardous waste with other types of waste,
b) pouring oil-derivative waste into:
   – publicly accessible bins and containers which are located on the wharfs and halls,
   – containers for scrap metal, slag and mixed waste (for segregation) from vessels.

In authors' opinion, efficient segregation of waste will contribute to a decrease in costs which are related to the recycling of waste generated during the construction of offshore vessels.

The lack of pro-ecological awareness in shipyard workers and cooperators who work at the shipyard has currently contributed to some serious damages which have been caused by:

a) improper storage and disposal of chemical substances and waste (overfilled containers which leak into the soil and water),
b) faulty equipment,
c) mixing hazardous waste with other types of waste,
d) discharging of oil-derivative substances from vessels into publicly accessible bins and containers located on the wharfs and halls and intended for the collection of scrap metal, slag and mixed waste (for segregation),

The impact of hazardous substances on natural environment depends on:

a) the size of the spillage into the soil and water,
b) the efficiency of preventive operations,
c) the efficiency of spillage collection,
d) the characteristics of the spillage substance: decomposition time, the state of matter, toxicity of concentration.

The authors believe that it is necessary to appoint persons (or groups) who shall be responsible for the following issues at each vessel:

a) proper marking of places where all the waste generated on the vessels shall be disposed,
b) proper supervision over the storage of all the waste collected on the vessels by the shipyard workers and their cooperators,
c) instructions for the above-mentioned people on how to store hazardous waste,
d) proper response to the incorrect waste storage at the places which are not intended for such purposes.

Additionally, the assigned people would be responsible for the proper marking of hazardous waste and chemical substances, namely:

a) hazardous waste,
b) highly flammable substances,
c) substances hazardous for natural environment,
d) toxic substances,
e) explosives,
f) caustic substances,
g) biologically hazardous substances,
h) substances causing allergic response to the human respiratory system and sharp edges of scrap steel.

Conclusions

The article presents the most important problems referring to the protection of natural environment and reverse logistics related to waste disposal which are faced every day at the discussed shipyard during the construction of offshore vessels.

In their article, the authors present the process of constructing an offshore vessel. Some indispensable processes involved in such production at a shipyard are: welding, plate cutting, various types of beveling and chamfering operations, painting. All the presented problems affect green logistics, involving environmental aspects which directly or indirectly influence natural environment:

a) generation of hazardous waste during the assembly of hull sections,
b) excessive emission of pollutants generated during welding operations into atmospheric air;
c) excessive emission of dust generated during the cleaning of hulls and steel elements before painting,
d) excessive use of paint and increased emission of volatile organic compounds into atmospheric air; improper discharge of pre-treated waste generated during the cleaning of hulls into water.

The authors of the article believe that all the most significant changes in favour of natural environment in the discussed shipyard should be implemented through the level of the company management. It would facilitate the implementation of essential transformation in the ecological awareness of the shipyard workers

as regards the protection of natural environment which is directly related to their work.

The management staff of the shipyard should also consider the fact that they are mainly responsible for the enhancement of ecological awareness at their workplace. They set an example for their employees and develop patterns of behaviour to be followed; as a result the production workers should follow the proper procedures during their work.

All the efforts listed in the article are aimed at the enhancement of ecological awareness. The management methods should be flexible so that they can be quickly adjusted to the current events. Such an assumption comes from the concept of constant improvement of systems in order to adjust them to the current regulations.

The authors point out that an important aspect in the elimination of the discussed drawbacks is making the shipyard workers and their cooperators responsible for their performance at work. It mainly refers to the planning and organisation of the employees' own work in order to limit the amount of waste generated during their operations, and the storage of all the generated waste which should be preceded by proper segregation at the proper places. In the authors' opinion, proper segregation of waste types, their marking and disposal in line with the ecological principles of green logistics shall considerably affect a decrease in the pollution of the soil, water and atmospheric air in the area of the shipyard.

In this work, the authors have used the following research methods and tools:

a) practical direct observations on offshore units,
b) interviews with the main technologist and production operators,
c) delphi method, i.e. employing the expert knowledge, experience, and opinions of practitioners in the shipyard field with whom the authors cooperated on the project,
d) results obtained by means of statistical methods.

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Corresponding authors

Radosław Drozd can be contacted at: rdrozd@zie.pg.gda.pl
Marcin Kisielewski can be contacted at: mkisielewski@wsb.gda.pl

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Leszek Reszka

Department of Logistics, Faculty of Economics, University of Gdańsk

THE APPLICABILITY OF THE SIMOS' METHOD TO DETERMINATION OF WEIGHTS IN OPTIMAL MULTICRITERIA DECISION MAKING IN LOGISTICS

Abstract

The goal of the article was to present the possibilities of application of the Simos' method to weight's determination in the optimal multicriteria decision making in logistics on example choice of supplier. To illustrate the problem a critical analysis of the methods described in the literature in the area of logistics was conducted. They were also confronted with so-called Simos' method described in the literature in the area of operations research in the so called basic and modified version.

Keywords: logistics, optimization, multicriteria decision making

Introduction

One of the most appreciated competencies of logistics department employees, indicated by employers, is the ability to make quick decisions (Reszka, 2016, p. 208), which in the logistics for a company covers a wide range of various problems related to its functioning. It is true that, to a large extent this ability is determined by the characteristics of the human personality, but it belongs also to the so-called social competences, which can also be developed in the education process of future managers. Nowadays, in the decision-making process the methods and tools are indispensable elements which help to rationalize this process.

The majority of decision problems in logistics are multicriteria ones. Therefore, today logistician often has to choose the best, optimal option from a number of variants of the decision-making, taking into account more than one criterion. Criteria which have to be taken into consideration are often concurrent. That is why it often becomes impossible to select a variant in which all of them would be rated the highest (Anholcer, 2009, p. 104).

There are many examples of such decision problems. Some of them can be mentioned here among others: the choice of means of transport, the choice of software to support logistics processes, the problem of storage location or choice of supplier. And so, when choosing a mode of transport, logistician usually takes into account: costs, transportation time, reliability, availability, space and security (Sierpiński, 2001, p. 849; Coyle, Bardi, Langley, 2002, pp. 413–427). When selecting software to support logistics processes they should take into account: the functionality and flexibility of the system, the ability to add new modules and technical support after its implementation, but also its price, hardware requirements, implementation time and probability of failure (*Metody i kryteria wyboru systemu ERP*, 2016). Among the most important criteria for the storage location there can be listed: proximity to suppliers and customers, availability of employees, relations with local authorities, real estate costs and the state of infrastructure and transportation costs (Stefaniaka, 2016).

Choosing of a supplier is the most widely described in the literature multicriteria decision problem of logistics (Skowronek, Sarjusz-Wolski, 2003, pp. 188–196; Ciesielski, 2006, pp. 100–105). This problem will be used to fulfill the basic purpose of this article, which is to make a critical analysis of the methods described in the studies in the area of logistics and present the possibilities of application Simos' method, known from the literature of operations research.

1. Classical methods for solving multi-criteria optimization problems

As an example, to present the classical procedures for solving multi-criteria optimization problems will be used hypothetical decision-making situation to choose one of five suppliers (A, B, C, D, E) on the basis of five criteria: price of the product, the quality, delivery time, the required payment period and the distance to the supplier (shown in table 1).

Table 1. Information about the suppliers divided into the criteria taken into consideration

Suppliers	Criteria				
	K_1 price of product ($/unit)	K_2 quality of product (points)	K_3 time of realization (days)	K_4 required payment period (days)	K_5 distance (km)
A	80	4	14	7	50
B	200	3	7	14	40
C	150	3	7	10	30
D	150	2	7	14	40
E	150	4	2	1	30

Source: (own elaboration)

The starting point for the procedure is to assign ratings to each criterion for each supplier using a uniform scale for all the criteria, e.g. increasing from 1 to 5, as illustrated in the table 2.

Table 2. Evaluation of criteria in a uniform scale

Suppliers	Criteria				
	K_1 price of product ($/unit)	K_2 quality of product (points)	K_3 time of realization (days)	K_4 required payment period (days)	K_5 distance (km)
A	5	2	2	3	1
B	1	3	3	5	2
C	3	3	3	4	5
D	3	2	3	5	2
E	3	4	5	2	2

Source: (own elaboration based on data from table 1)

After assigning the ratings, the overall assessment for each supplier is calculated as the sum of ratings of individual criteria (1), or their arithmetic average (2) which enables to obtain the overall assessment in the same scale as the assessment of individual criteria.

$$G_j = \sum_{i=1}^{m} k_j \tag{1}$$

where:
k_{ij} – assessment of criterion i for supplier j; $i \in \{1,\ldots, m\}$

$$G_j = \frac{\sum_{i=1}^{m} k_j}{m} \tag{2}$$

[notation as above].

After the simple calculations, the highest assessment gets supplier E, having the sum equal to 17 points, and the average 3.4. Further down successively are ranked suppliers: C (sum 16 and average 3.2), then *ex aequo* A and D (15 and 3) and B (14 and 2.8) (Chaberek, 2002, p. 47).

The main drawback of the procedure described above is that it does not differentiate criteria for significance from the point of view of a particular enterprise which makes the choice. Therefore, it is recommended in the logistics literature (Skowronek, Sarjusz-Wolski, 2003, pp. 192–193) to visualize assessments using the so-called radar chart (fig. 1).

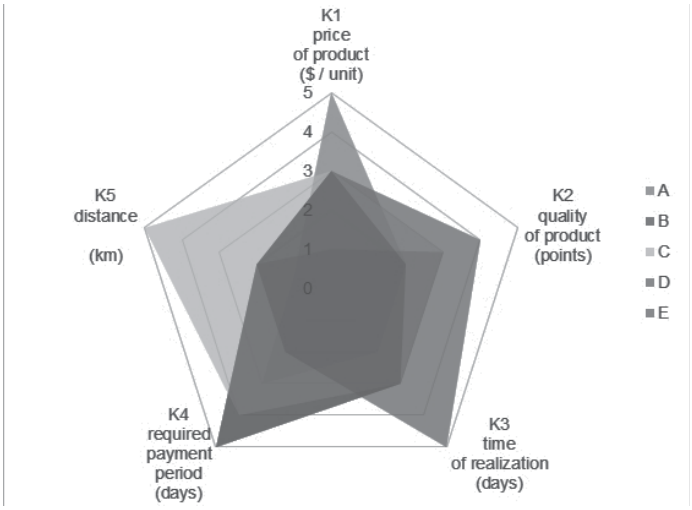

Figure 1.Visualization of suppliers' assessments using radar chart
Source: (own elaboration based on data from table 1)

The chart clearly illustrates advantages of each provider taking into account different criteria (e.g. supplier A predominates in terms of price, the supplier D – taking into account the required payment period, and the supplier E – time), but it is difficult to assess them precisely based on it and (what is connected with it) a good, accurate choice.

That is why it is reasonable in this case to introduce so-called weights to differentiate their meaning. After assigning weights overall assessment is expressed as the sum of the products of ratings criteria and corresponding weights (3), or the arithmetic weighted average (4):

$$G_j = \sum_{i=1}^{m} w_i k_{ij} \tag{3}$$

where:
w_i – weight of criterion i
[other notation as above],

$$G_j = \frac{\sum_{i=1}^{m} w_i k_{ij}}{\sum_{i=1}^{m} w_j} \tag{4}$$

[notation as above].

In the described situation, assigning for example, the highest weight to the criterion of quality (5 points), slightly lower to price (4 points), followed by the time of realization and the required payment period (2 points), whereas the distance (1 point), the supplier A would be selected, getting sum of the products equal to 51, a weighted average of 3.6. Leader of previous ranking would have the second place

(with grades equal to 48 and 3.4). Followed place would be taken by suppliers: C (44 and 3.1), D (40 and 2.9) and B (37 and 2.6) (Chaberek, 2002, p. 47).

An undoubted advantage of the procedure described above is a differentiation of the criteria obtained thanks to the weights. On the other hand its main drawback is the lack of formalized procedures for the weights' assignment, which may cause the introduction of an element of randomness to the results. Therefore, it seems reasonable to conduct research of exploration other areas of knowledge to find methods, not necessarily described in the strictly logistical literature, which also became the task of the author of this study, directing his attention to the achievements in the field of operational research. Exploration of the literature from that area has resulted in finding the so-called Simos' method, which application to solve the described decision situation is presented in the next section of the article.

2. Simos' method

Jean Simos is an international expert in the field of multi-criteria decision-making methods and their implementation in the areas of health and environment. He is the Director Environment and Health Research Group – GRES at the University of Geneva in Switzerland (Website of the University of Geneva, 2016). In 1990 he presented a method that allows the decision maker to weight criteria when solving multi-criteria decision-making problems, thus enabling the ordering of importance of the criteria (Simos, 1990 after: Figueira, Roy, 2002, p. 317).

In the Simons' method the weights are determined using two sets of cards, which allows to visualize the decision problem and to understand it in an intuitive way. The first set of cards are written ones. They contain information about the criteria, such as, primarily, their names and optionally other additional information. The second type of cards are blank cards. Their number declared by the manager, is dependent from perceived by him differentiation of criteria. After receiving the cards, the manager arranges the written cards by importance of criteria, from the least to the most important one. The Cards representing equally important criteria are fastened together using a stapler or rubber. An example of such an arrangement for the discussed in the article these decision-making problem is shown in figure 2.

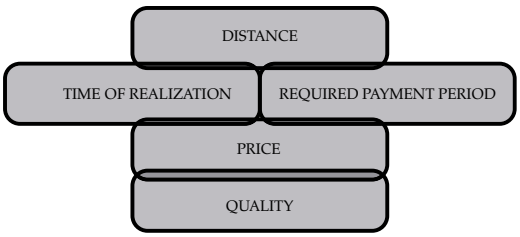

Figure 2. Visualization of significance hierarchy of supplier evaluation criteria
Source: (own elaboration based on data from table 1)

The blank cards are used to differentiate distances between the cards (or their connected sets). When there is no card between the two written cards, then distance between the importance of corresponding criteria is equal to u – unit of measurement. One blank card means a distance equal to 2u, two blank cards – 3u etc., as illustrated in figure 3.

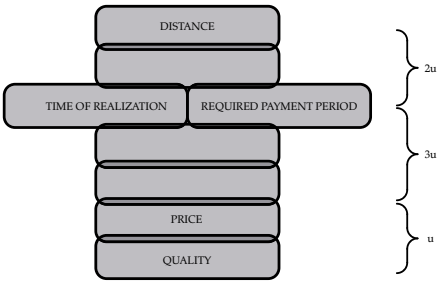

Figure 3. Determining the distance between the importance of individual criteria for supplier evaluation
Source: (own elaboration based on data from table 1)

With such a visualized hierarchy of criteria along with distances between the significance of them, data can be presented in a table (the first two columns of table 3), which will also be used to illustrate the next steps of the procedure. The next step is to fill in the third column the information about the quantity of cards in the position of rank and the total quantity of cards used by the decision maker. Then the cards receive serial numbers in the form of successive integers (fourth column of table 3). Based on the numbers, for written cards only, the non-normalized weights are calculated as the ratio of the sum of the serial numbers assigned to a particular place in the rank by the quantity of the numbers (the fifth column of table 3). Simos called these weights as the average ones (Figueira, Roy, 2002, p. 330). The last step is the normalization of weights to obtain their sum equal to one (the last two columns of table 3) (Górecka, 2009, pp. 192–197; Kobryń, 2014, pp. 50–52; Figueira, Roy, 2002, pp. 318–319). The normalized weights were called the relative ones by Simos (Figueira, Roy, 2002, p. 330).

Table 3. Determination of weights to the criteria according to the Simos' procedure

Position in the rank	Set of cards	Quantity of cards	Numbers of cards	Non-normalized weights	Normalized weights	Total
1	K_5	1	1	1	0.04	0.04
2	blank	1	2	X	X	X
3	K_3, K_4	2	3, 4	(3+4)/2=3.5	0.15	0.30
4	blank	1	5	X	X	X
4	blank	1	6	X	X	X
6	K1	1	7	7	0.30	0.30
7	K2	1	8	8	0.35	0.35
Sum	X	8	X	X	X	1.00

Source: (own elaboration based on data from table 1)

After the weights determination procedure, the overall assessments for individual suppliers can be calculated according to the presented literature logistics, also given earlier in the article, sum of the products' formula (3)[1]. In this way, the supplier A would be selected (getting overall assessment equal to 3.7). The next place would be taken by suppliers: E (3.4), C (3.2), D (2.9) and B (2.7).

The above presented Simos' method has been used to solve many specific decision problems. However in literature from the area of operations research (Figueira, Roy, 2002, pp. 320–321) also some of its shortcomings are indicated, which mainly include the fact that it takes into account the distance between the importance of individual criteria, but it excludes information how many times the most important criterion is more important than the least important one for the decision-maker. Actually this aspect (the ratio of the most important criterion to the least important was) was added to the procedure called the Simos' revised method. This ratio was marked as *s*, and on the basis of it the distance u is calculated from:

$$u = \frac{s - 1}{\text{the total number of positions in the rank}} \tag{5}$$

Assuming that in the presented example the decision-maker said that quality of the product is ten times more important than the distance to the supplier, the distance u would be equal to 1.5. Also in this version of the Simos' procedure, non-normalized weights are calculated (taking into account the calculated u distance, and based on them, similar to the basic version, normalized weights (tab. 4) (Górecka, 2009, pp. 197–202; Kobryń, 2014, pp. 52–55; Figueira, Roy, 2002, s. 322–324).

Table 4. Determination of weights to the criteria according to the revised Simos' procedure

Position in the rank	Card	Non-normalized weights	Normalized weights
1	K_5	1	0.04
2	blank	~~2.5~~	
3	K_3	4	0.15
3	K_3	4	0.15
4	blank	~~5.5~~	
5	blank	~~7~~	
6	K_1	8.5	0.31
7	K_2	10	0.36
Sum	**X**	**27.5**	**1.00**

Source: (own elaboration based on data from table 1)

Also here, after weights determination procedure the overall assessments are calculated, according to equation (3).The result of these activities for the presented example is the choice of supplier A (with a score of 3.8), next place are taken by suppliers: E (3.4), C (3.1), D (2.9) and B (2.6).

[1] Due to the fact that the sum of weights is equal to one, the sum of products is the same as the arithmetic weighted average.

Conclusion

It should be noted that although final, overall assessments of individual suppliers in the example do not differ significantly from the results obtained using the "classical" and the primary Simos' method, yet the formal procedure for weights determination to each criterion makes the decision-making process less random and more objective. Logistic manager equipped with such tools has a greater awareness of the accuracy of the decisions taken by them, especially that the intuitive choice of one of many variants in such a situation is actually random, often made on impulse. That's why, the methods of ordering the process, making it more objective, should be sought. A sample of results of this type of research has been outlined in this article.

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Corresponding author

Leszek Reszka can be contacted at: leszek.reszka@ug.edu.pl

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Julia Siderska[a)], Katarzyna Perkowska

a) International China and Central-Eastern Europe Institute of Logistics and Service Science Faculty of Management Engineering, Białystok University of Technology

APPLICATION OF COMPUTER SIMULATION IN IMPROVING THE PROCESS OF SCREWS PRODUCTION

Abstract

The aim of this work is to present and discuss the possibility of using computer simulation to improve the production flow of sheet metal screws in the carpentry plant. The paper includes descriptive and schematic characterization of the present production system of the plant in one of the Polish companies. Using the Tecnomatix Plant Simulation software, a digital model of the process line was drawn up, mirroring the spatial arrangement of workstations in the production hall and their operators, as well as actual processing times and set-up times of each machine. Simulation was performed to identify bottlenecks in the entire production process, and several modifications were proposed on that basis so as to optimize the workloads of the workstations and increase production.

Keywords: computer simulation, Tecnomatix Plant Simulation, screw manufacturing, production process, bottlenecks

Introduction

Knowledge on the production capacity of the company is extremely important from the point of view of company management. It allows to plan the necessary preparation work at an early stage, to reduce the costs connected with mistakes of configuration of production lines, and it ensures more efficient use of the whole infrastructure.

Access to production data in real life, taking into consideration the dynamic changing conditions, is necessary to effectively plan, simulate and supervise production. Companies operating in different sectors of the economy are more and more generally applying IT solutions to optimize production processes and systems

by improving the handling of materials and performance parameters. Computer simulations are the techniques and tools most frequently used in manufacturing and industrial engineering.

The simulation can be applied whether a new facility is being planned or an existing one needs to be optimized. The simulation helps to (Bangsow, 2010, pp. 1–6):

- determine and optimize the times, such as processing time, failure time, set-up time, recovery time, etc., and the throughput of the plant,
- determine the size of buffers and the number of machines,
- determine how many workers and staff members are required for the intended throughput,
- minimize the investment cost for production lines without jeopardizing required output,
- optimize an existing facility,
- optimize the performance of existing production systems,
- optimize the sequence of orders that have to be fulfilled to make as few tool changes necessary as possible.

The analysis of the literature of the subject gives us relatively few publications which discuss the application of Tecnomatix Plant Simulation in production engineering and logistics. They refer to interesting solutions and lead to interesting conclusions. Most articles are by European researchers from: Slovakia (Filo *et al.*, 2013, pp. 165–168; Kliment, Trebuna, 2014, pp. 17–21; Kliment, Trebuna, Straka, 2014, pp. 286–289) Poland (Danilczuk, Cechowicz, Gola, 2014, pp. 25–42; Kłosowski, 2011, pp. 29–37; Kostrzewski, 2013, pp. 5–12), the Czech Republic (Boruvka, Manlig, Kloud, 2011, pp. 24–28) or Germany (Gutenschwager *et al.*, 2012).

1. Simulations in Tecnomatix Plant Simulation

Identifying errors in the planning phase is much cheaper for a company than doing that after the start-up of a project or its full implementation. Performing a computer simulation makes it possible to assess whether the project was designed properly and is being carried out as it should. Simulation provides a comprehensive perception of the studied process or product, allows to conduct multi-criteria analysis, and to test many scenarios. That is why computer systems are becoming necessary tools supporting the design and improvement of business processes.

The article discusses the proposal of improving the production flow of sheet metal screws in the carpentry plant. Simulation was performed with the usage of Tecnomatix Plant Simulation software. It is an object-oriented 3D program used to simulate discrete events, which allows to quickly and intuitively create realistic, digital production systems and thus test the properties of them and optimize their performance. The application is manufactured by the German company Siemens PLM Software, which is the leading global supplier of software for PLM (Product Lifecycle Management) and MOM (Manufacturing Operations Management). Digital models enable to perform experiments and test "what if" scenarios without

disturbing the work of production systems or, in the case of the planning process, long before their assembly.

Tecnomatix Plant Simulation provides effective and simple analytic tools which allow the detection of bottlenecks (Bottleneck Analyzer), tracking material flow (Sankey Diagrams) and identification of resource excess (Chart Wizard). A very important advantage of this program from the point of view of the author's scientific interest is that it provides integrated optimization tools. These include mainly: Genethic Algorithm Wizard, Layout Optimizer, Neural and Experiment Manager.

2. Process of screws production

The object of the discussed process is case hardened, 25 μm zinc plated, low carbon steel screws with steel (aluminium) washers. They are used to fix metal sheets to wooden structures. The analyzed company has modern machinery and qualified staff. However, the maximum production capacity has not been achieved, and the current production does not meet the current market demand. In this paper the possibilities of improving the production flow of sheet metal screws and increasing the throughput of the plant are discussed.

Let's consider the production line shown in figure 1. It is a digital model representing the real process of screw production, designed by the authors with the use of the Tecnomatix Plant Simulation software. The manufacture of farmer screws involves the use of steel bar ϕ6, aluminum plate and self-vulcanizing rubber. The manufacturing process can be divided into preparing the proper screw and the washer.

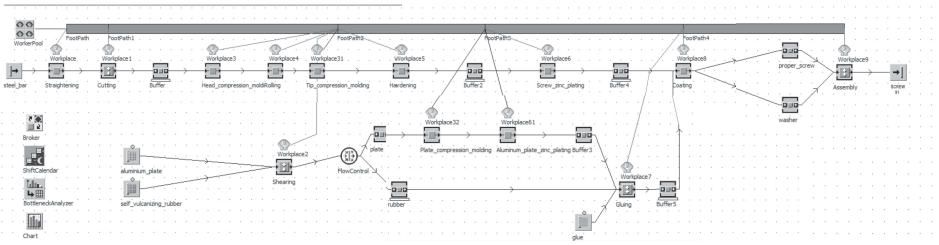

Figure. 1. Digital model of screws production process
Source: (own elaboration)

The first stage of manufacturing the proper screw involves straightening the steel bar (the "Straightening" workstation). The speed of drawing steel through the straightener reel is approx. 100 mm/s. The 20 meter steel bars used for the manufacture of farmer screws are purchased in reels. The time of straightening one reel is 3 minutes and 20 seconds. The set up time, which involves placing the bar in a straightener and setting the parameters, lasts 7 minutes. The next stage of manufacture is cutting the bar with a cutting-off machine (the "Cutting" workstation). The processing time of this operation is 5 seconds. One reel is cut into 100 bars. The set

up time, done after cutting each reel, lasts 7 minutes. It involves placing the bar in a straightener and setting the process parameters. The next operation is compression molding of the screw head (the "Head_compression_molding" workstation). The time of completing this operation is 6 seconds for one bar. The set up time of the compression molding machine is done after each batch of 100 details, lasts 5 minutes, and involves setting the process parameters and placing the raw material in the machine. The next operation is rolling the screw thread (the "Rolling" workstation). The time of threading one screw is 15 seconds. The set up is done before each bar and involves removing the previously rolled detail, fixing the new element in the machine, and setting the process parameters. It lasts 1 minute. The next stage of manufacture of farmer screws is compression molding of the self-drilling tip (the "Tip_compression_molding" workstation). The processing time of this operation is 4 seconds. The set up time of the compression molding machine lasts 5 minutes, and involves setting the process parameters and placing the material in the machine. It is done after each batch of 100 details. The next step is hardening the screw (the "Hardening" workstation). Each detail is hardened for 15 minutes, and batches have 150 pieces each. The set up time is 20 minutes and it involves preparing the batch of bars and the suitable process parameters. The aim of the next operation, zinc plating (the "Screw_zinc_plating" workstation), is to reduce the susceptibility to corrosion. It is carried out for 15 minutes in batches of 150 pieces. The set up time lasts 10 minutes and involves removing details from the zinc plating bath and placing new ones in it. Then, the screw is transferred to the coating workstation (the "Coating" workstation), where it is covered with powder coating. The unit time of the operation for one screw is 5 seconds. Coating is carried out in batches of 100 pieces. set up time lasts 5 minutes and is done after each batch. It involves placing the bars on a stand. After the completion of all these operations, the screw is transferred to the assembling workstation.

Manufacturing the washer begins at the shearing workstation, where elements are cut out of aluminum plate and self-vulcanizing rubber with a press (the "Shearing" workstation). The processing time of shearing is 3 seconds. The set up time is done after cutting each sheet and lasts 10 minutes. It involves placing a sheet of the material in the machine and setting the process parameters. Self-vulcanizing rubber elements are transferred directly to the gluing workstation while the details cut out of the metal plate are being compression molded (the "Plate_compression_molding" workstation). The time of forming one semi-manufacture of the metal sheet is 3 seconds. The set up time involves placing the material in the machine feeder. It is done after a batch of 250 elements and lasts 5 minutes. Subsequently, the aluminum plate details are zinc plated (the "Aluminun_plate_zinc_plating" workstation). The operation lasts 25 minutes and the batches have 250 pieces each. The set up time involves removing details from the zinc plating bath and placing new ones in it; it lasts 10 minutes. The assembly of a washer involves gluing the aluminum plate and self-vulcanizing rubber together (the "Gluing" workstation). The unit time of the operation is 3 seconds, while the set up time, which involves placing details in the machine, lasts 10 seconds. The assembled washer is then coated (the "Coating" workstation). The time of the operation for

one washer is 5 seconds. Coating is carried out in batches of 250 pieces. The set up lasts 5 minutes, is done after each batch, and involves placing the washers on a stand. After the completion of all these operations, the washer is transferred to the assembling workstation.

Table 1. Processing times and set-up times of all workstations

Proper screw						
Blank *Rolling bar Ø 6*						
No. operation	Workstation	Subject operation	Set up after	Time in minutes		
				t_{pz}	t_j	Overall
010	Straightening	Straightening the steel bar	1	7	3.33	10.33
020	Cutting	Cutting the steel bar	1	7	0.08	7.08
030	Head compressionmmolding	Compression molding of the screw head	100	5	0.1	5.1
040	Rolling	Rolling the screw thread	1	1	0.25	1.25
050	Tip compression molding	Compression molding of the self-drilling tip	100	5	0.1	5.1
060	Hardening	Hardening the screw	Part 150	20	15	35
070	Screw zinc plating	Zinc plating	Part 150	10	15	25
080	Coating	Coating	Part 100	5	8.33	13.33
Washer						
Blank aluminum plate, self-vulcanizing rubber						
No. operation	Workstation	Subject operation	Set up after	Time in minutes		
				t_{pz}	t_j	Overall
010	Shearing	Aluminum plate shearing	1	10	3	13
020		Self-vulcanizing rubber shearing	1	10	3	13
030	Plate compression molding	Plate compression molding	250	5	0.05	5.05
040	Aluminum plate zinc plating	Aluminum plate zinc plating	Part 200	10	20	30
050	Gluing	Gluing the aluminum plate and self-vulcanizing rubber together	1	0.17	0.05	0.22
060	Coating	Coating	Part 250	5	0.08	5.08
Farmer screws						
Blank *Proper screw, washer*						
No operation	Workstation	Subject operation	Set up after	Time in minutes		
				t_{pz}	t_j	Overall
010	Assembly	Assembly of the proper screw and the washer together	1	0.2	0.07	0.27

Source: (own elaboration)

The last stage of manufacturing farmer screws is the assembly of the proper screw and the washer together (the "Assembly" workstation). The processing time of the operation is 3 seconds. Table 1 presents processing times and set-up times of all workstations. These are real information, received by the authors, concerning discussed production process.

3. Discussion of the results

The fundamental goal of the simulation analysis was to identify all the problems and disturbances occurring in the production process. The experiments allowed to identify the workstations which limit the production capacity of the plant (so-called bottlenecks). It was also possible to analyze the workloads of each machine.

The conducted simulations led to the conclusion that most machines are blocked during the production. Statistical analyses of work at each workstation performed after the whole production process showed that only 10% of the almost all machines' capacity was actually used. Coating machine is working only 5% of time, the rest of time is needed for its' set-up process. Zinc_plating workstation is blocked nearly 70% of time and it is considered by authors as the bottleneck of the whole production process.

In addition, the appropriate statistics were defined at the model output, which summarized the manufactured and assembled elements. The production process at the modeled plant involves two 8-hour shifts. Within one working day, that is within 16 hours of technological process, the production capacity for machines and workstations settings defined in mentioned was only 91 screws.

The authors formulated the research task: how to optimize the production and increase the throughput of the plant? The objective of the process improvement was to produce at least 500 screws daily and use the machines more effectively. The authors considered many changes of the workstations' number and their arrangement, different set-up and processing times of workstations, etc. Many computer simulations concerning different scenarios were conducted. They made it possible to conclude about the most effective and the most efficient improvements in the discussed production process. The above-mentioned assumptions were achieved thanks to:

– dividing zinc plating into two workstations,
– dividing coating into two workstations (separate processing of washers and screws),
– creating two additional assembly workstations.

The results of the simulation after introducing an extra zinc plating and coating workstation into the discussed production process are shown in figure 2.

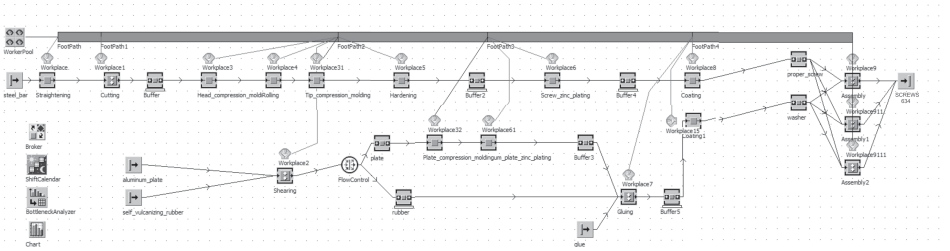

Figure. 2. Change of production volume after introducing new workstations
Source: (own elaboration)

Presented on the figure 2 solution enabled to gain very satisfying effects, as it allowed to increase the production up to 634 screws within 16 hours. The statistics concerning the processing of machines in the discussed production process were also analyzed. The zinc plating machine and coating machine are working about appropriately 60% and 40% of time now. They are not the bottlenecks of the process from this moment. The whole manufacturing process is not blocked by those workstations any more.

Conclusions

The simulation analysis carried out using the digital model developed in the Tecnomatix Plant Simulation environment provided detailed data which allowed to thoroughly analyze the flow of screws production process. This enabled to identify the main causes of low production, to optimize the workloads of the individual stations and to identify bottlenecks in the entire production process. Identified problems will help the company to implement improvements and thus contribute to the increase of its real production capacity and organization of work. Several modifications were proposed on that basis so as to optimize the workloads of the workstations and increase production.

The literature review exposed comparatively few articles which discuss the application of Tecnomatix Plant Simulation in manufacturing engineering. However they refer to interesting solutions and lead to appealing conclusions. Most papers are written by European researchers and they mainly relate to organization of manufacturing halls, whole production lines or individual processes. The results of conducted research and performed simulations and analyses of the recent applications of Tecnomatix in modeling and simulating production processes confirmed the authors assumptions that it is an effective and practical useful tool. This software can be successfully applied e.g. for optimizing resource consumption and throughput of the plant, determining the most effective number of workstations and staff members required for the intended throughput and optimizing an existing facilities and the performance of existing production systems.

Further research of the authors will focus on application of artificial intelligence tools (mainly genetic algorithms and artificial neural networks) in optimizing the efficiency of production systems.

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Corresponding authors

Julia Siderska can be contacted at: j.siderska@pb.edu.pl
Katarzyna Perkowska can be contacted at: kperkowska10@gmail.com

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Michał Oleszczak

Department of Logistics, Faculty of Economic Sciences and Management, Nicolaus Copernicus University

INFORMATION AS A RESOURCE IN LOGISTICS THEORY AND PRACTICE

Abstract

Article presents information as a valuable strategic resource and its increasing role over time, basing on polish and foreign definitions of logistics. Lastly, a definition for information logistics has been proposed.

Keywords: information, logistics

Introduction

People undertake various economical activities in order to satisfy human needs. These activities are persistent in time, because human needs are endless. As stated by Roman Milewski and Eugeniusz Kwiatkowski (2008, p. 7), due to the human needs sustainability and their further growth, the economic activity of the people is carried out continuously in the sphere of production, distribution, exchange, and consumption. The above considerations lead to the conclusion that this is a process, known by Polish word *gospodarowanie*, which is defined by Adam Cygan (1999, p. 50) as the allocation of the available resources between the various applications, which is a human activity resulting from aspiration to fulfilling unlimited needs as far as possible in the limited resources condition. This process is driven by the people and for successful operation it requires proper resources. One of these precious resources is information, which has to be delivered in right way.

1. Information as an important strategic resource

Traditionally economic resources can be categorized into three main factors of production, which are: labour, capital and land. Labour is related to the use of human resources. Capital consists of financial resources and assets. Land is linked with the use of raw materials and natural resources. With the development of the resource-based view in management science resource classification has been expanded and extended to a wider and wider collection of intangible assets, whose importance increases with the process of its transformation to a knowledge-based economy. Joanna Bednarz (2013, p. 178) divides economic resources into two main categories: tangible and intangible resources, where first category contains: fixed assets, current assets and financial resources. The second category consist of human, market and organizational resources. Ricky W. Griffin (2010, p. 5) has a different approach and classifies resources into four main groups: human resources, financial resources, physical resources and information resources. This leads to a question: are information resources strategically important for an enterprise, if they represent one of the main resources group in economy?

According to Bohdan Godziszewski (2001, p. 76.) enterprise resources and competencies are of strategic importance for company operation, because of their influence on the formation of competitive and market advantage and their ability to compete. Each resource has a different strategic value and therefore there is a need for their proper identification and evaluation. A significant contribution to the development of resource-based view in strategic management was done by Jay B. Barney (1991, pp. 99–120), who created a framework, that helps to identify resources that build a sustainable competitive advantage, which should be "VRIN":

– valuable,
– rare,
– inimitable,
– non-substitutable.

Resources can be considered valuable if they help utilize market opportunities or eliminate threats, leading to an increase in revenues or in a decrease of company costs. The identical resources cannot be in the possession of an excessive number of market participants and ensure a sustainable competitive advantage at the same time, so therefore they should be sufficiently rare. In order to reduce the availability of the same resource by competitors, one should acquire resources difficult to imitate or protect existing ones from imitation. Resources are protected from competition if the cost of acquiring, developing or copying by a competitor is greater than its value, but protection from mitigation would have lost its importance if there are substitutes on the market. For example: the company has developed technology of ultra-light metal composites for the aerospace industry and protected it with relevant patents, then a competitor develops a substitute – similar product based on carbon fibres, effectively breaking a sustainable competitive advantage by depreciation of a valuable resource because of substitution.

Information resources can be valuable, rare, inimitable and non-substitutable. Significant value of strategic information can be demonstrated on zero-sum game theory simulations (Oleszczak, 2014, pp. 261–270). For example: a company has

acquired verified market plans of the competitor. They can be used in future market decisions. This can lead to a greater income for the company or reduced loss, therefore making this information valuable with its worth based on potential net profit change. Not all information a company can buy. Some will have to be worked out internally, which means that some information may be available to only one enterprise, therefore making it a very rare resource. If information assets are properly protected from unauthorized copying and "leaks" to the environment, then they are difficult to imitate, or else their duplication may occur in only few seconds. In the absence of relevant information, replacing it with other goods seems to be impossible. Decision-making process can be carried out in the absence of required information, but it will take place in conditions of substantial uncertainty and risk. According to Adrian Slywotzky (2007) risk is an expensive substitute for the information. In the absence of full information in the production process, there will be increased materials or energy usage, so the purchase of relevant information may lead to significant savings in material and energy, which are limited substitutes for information.

These considerations lead to the conclusion, that information may be one of the strategic resources of the company and can contribute to a process of building a sustainable competitive advantage of the enterprise. In macroeconomic terms, the increased use of information as a resource by businesses leads to the formation of information society. Therefore, there is a need of proper acquisition, processing and distribution of information in a micro- and macro-economic scale and these operations can be supported by logistics.

2. Information resources role in logistics definitions

Logistics has its origins in ancient times, originally it was related to the supply and movement of troops. In the twentieth century, first definitions of business logistics emerged and since then, they were changing according to economic development and technical progress. Up to present times there has been no single, generally accepted and universally applicable definition of logistics, but often logistics definitions have many common elements. American Marketing Association in 1935 has defined logistics as the "various corresponding enterprise activities during material resources transfer from the production location to the consumption area, including the service process" (Qin, 2009, p. 248). The development of information technology and the information status in the economy was reflected in the advanced conception of logistics. In 1985 the Council of Logistics Management[1] defined the logistics as „the process of plan, implementation and administration for the efficient and beneficial movement and safekeeping of raw materials, semi-products and related information from production location to consumption location to satisfy customers' requirements. These activities include, but are not limited to customer service, portage and transportation, warehouses keeping, choosing the factory and warehouses

[1] In 2005 *Council of Logistics Management* changed name to *Council of Supply Chain Management Professionals*.

location, stock management, accepting orders, circulation information, purchasing, loading and unloading, accessory supplying and service providing, castoff recycle, packing, return of goods, and requirement forecasting, etc." (Qin, 2009, p. 248). The definition of logistics is expanding here with the notion of information, but only that kind of information, that is closely linked with the movement of materials, for example: bill of lading or settlement documents. In the 1990s there was further growth of information supply and demand, therefore role of information has been emphasized in logistics definition. In the year 1996 logistics was defined by Logistix Partners Oy of Finland as a "business planning framework for the management of material, service, information and capital flows. It includes the increasingly complex information, communication and control systems required in today's business environment" (Sudalaimuthu, Raj, 2009, p. 2). In 1998 Stanisław Krawczyk (1998, p. 33) states that "logistics includes planning, coordination and controlling the course of – in terms of time and space – real processes, which are pursuing stated objectives. In particular it applies to the spatial and temporal: location, status and movement of goods which are subjects of these processes, including people, goods, information and financial means". One year later Mirosław Chaberek (1999, p. 139) defined the essence of logistics as a "controlling of all resources (materials, information, raw materials, products, employees, spare parts, intermediate goods, etc.) flow process in business organizations (in enterprises) and non-profit organisations: government offices, hospitals, the army and between these organizations (between the company and the supply markets, sales markets, companies and organizations network) – in the logistic channels and chains". Detailed set of chosen logistics definitions has been sorted chronologically in table 1.

Table 1. Logistics definitions with information roles

Year	Definition	Author	Country of origin	Information role
1935	Logistics is the various corresponding enterprise activities during material resources transfer from the production location to the consumption area, including the service process (Qin, 2009, p. 248).	American Marketing Association	United States of America	not included
1948	Logistics refers to the enterprise activity expense determined by the flow process of material resources (Qin, 2009, p. 248).	American Marketing Association	United States of America	not included
1960	Logistics is the wide range of activities during the finished products which effectively move from the end-point of the production line to the consumers, sometimes also including the transportation from the supply source of the raw material to starting point of the production (Qin, 2009, p. 248).	National Council of Physical Distribution Management	United States of America	not included
1970	A total approach to the management of all activities involved in physically acquiring, moving and storing raw materials, in-process inventory, and finished goods inventory from the point of origin to the point of use or consumption.	B. Lalonde, J. Grabner, J. Robeson (1970, p. 43)	United States of America	not included

Year	Definition	Author	Country of origin	Information role
1981	Logistics is the physical transfer of the material resources from the suppliers to the requesters, and the economic activities that create the time and location value. According to the range of the logistics, it includes the various activities such as packaging, loading and unloading, safekeeping, stock management, circulation, manufacturing, transportation and distribution. Without the above processes, the materials cannot be transferred (Qin, 2009, p. 249).	Japanese Comprehensive Research Institute	Japan	not included
1985	Logistics is the process of plan, implementation and administration for the efficient and beneficial movement and safekeeping of raw materials, semi-products and related information from production location to consumption location to satisfy customers' requirements. These activities include, but are not limited to customer service, portage and transportation, warehouses keeping, choosing the factory and warehouses location, stock management, accepting orders, circulation of information, purchasing, loading and unloading, accessory supplying and service providing, castoff recycle, packing, return of goods, and requirement forecasting, etc (Qin, 2009, p. 249).	Council of Logistics Management	United States of America	related to other subject
1992	Logistics is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders.	Christopher (2011, p. 2)	United Kingdom	related to other subject
1993	Field of knowledge that on the basis of information systems aims beyond enterprises divisions to their integration to ensure optimal supply chains shaping from the moment of raw materials obtainment, through their processing, distribution in various trade links, up to the final buyer.	Abt, Woźniak (1993, p. 19)	Poland	not included
1993	Logistics is usually understood as a term for managing the activities of movement and storage, to facilitate the flow of products from point of origin to a place of final consumption, as well as the related information, in order to offer customer an appropriate level of service at a reasonable cost. In this definition the term "product" should be treated in the broadest sense, understanding by it both goods and services.	Beier, Rutkowski (1995, p. 16)	Poland	related to other subject

Year	Definition	Author	Country of origin	Information role
1994	The logistics is the plan, implementation and control of transportation and arrangement of personnel and goods and the corresponding support activities in a system, to attain the particular purpose (Qin, 2009, p. 249).	European Logistics Association	Belgium	not included
1994	Supply chain management as the mean to the shortest cargo movement in time and space.	Gołembska (1994, p. 90)	Poland	not included
1995	Real processes of product flow from the point of origin to the final links, that meet the needs of consumer households and the production and investment needs of economic entities.	Skowronek, Sarjusz-Wolski (1995, p. 16)	Poland	not included
1996	Logistics is defined as a business planning framework for the management of material, service, information and capital flows. It includes the increasingly complex information, communication and control systems required in today's business environment (Sudalaimuthu, Raj, 2009, p. 2).	Logistix Partners Oy	Finland	independent subject (explicit)
1997	Logistics – The science of planning, organizing and managing activities that provide goods or services (Sudalaimuthu and Raj, 2009, p. 2).	Cox M.D., LogLink / Logistics World	United Kingdom	not included
1998	Integrated system for managing structures of the physical circulation of goods and their informational conditions in the scope of the enterprise and the whole market system – in terms of optimization of the realized actions and objectives.	Blaik (1998, pp. 14–15)	Poland	related to other subject
1998	Logistics – the process of planning, implementing, and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of meeting customer requirements (Sudalaimuthu, Raj, 2009, p. 2).	Canadian Association of Logistics Management	Canada	related to other subject
1998	Logistics is the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements (Sudalaimuthu, Raj, 2009, p. 2).	Council of Logistics Management	United States of America	related to other subject
1998	We are treating logistics in the broad sense as an integrated system of shaping and controlling physical movement of goods processes and their informational conditions to achieve the best possible relationship between the level of provided services (the level of customer service) and the level and structure of the associated costs.	Garbarski, Rutkowski, Wrzosek (1998, p. 390)	Poland	related to other subject

Year	Definition	Author	Country of origin	Information role
1998	Logistics includes planning, coordination and controlling the course of – in terms of time and space – real processes, which are pursuing stated objectives. In particular it applies to the spatial and temporal: location, status and movement of goods which are subjects of these processes, including people, goods, information and financial means.	Krawczyk (1998, p. 33)	Poland	independent subject (explicit)
1998	Logistics is a field of knowledge about the rational, comprehensive and economical, mass-energetic-informational securing the operations of activities systems with existing resources, constraints and disturbances in given conditions and time.	Niziński (1998, p. 29)	Poland	independent subject (explicit)
1999	The essence of logistics is controlling of all resources (materials, information, raw materials, products, employees, spare parts, intermediate goods, etc.) flow process in business organizations (in enterprises) and non-profit organisations: government offices, hospitals, the army and between these organizations (between the company and the supply markets, sales markets, companies and organizations network) – in the logistic channels and chains.	Chaberek (1999, p. 139)	Poland	independent subject (explicit)
2000	Logistics is shaping optimal material streams and related information streams to meet the needs in the considered area, at a reasonable cost. The material here means raw materials, semi-finished products, finished products, spare parts and consumables. The area has a territorial (faculty, plant, region) or industry division (food industry, distribution of medicines, etc.) meaning.	Fijałkowski (2000, p. 165)	Poland	related to other subject
2011	Logistics is a process, which provides services of any rational activity of human being, aiming to any given goal, and which consists in providing required resources in right place and time, in right quantities and of right quality and for right price in such a way, that the whole scope of activities aimed to reach the main goal is realized in effective, efficient and beneficial way.	Chaberek (2011, p. 211; 2014, p. 6)	Poland	independent subject (implicit)

Source: (own work based on included references. Polish definitions have been translated)

Above definitions have been placed on a chart 1, where the Y-axis contains information resources status ordinal number: 1 – there is no mentioned role for information in logistics definition, 2 – there is notion of information, but its role is bonded to other resource, 3 – information is one of the logistics subjects. There is clearly rising significance of information resources role in logistics, where in the beginning main logistics concern were flows of raw materials and tangible goods, then the logistic concept was expanded by including information related

to the physical flow of materials. Finally, the role of information in logistics advanced to an independent resource, that is logistics processes subject. Current scientific studies can contain logistics definitions with different roles for information resources, so there is a need of right definition for the information logistics, that properly describes its nature.

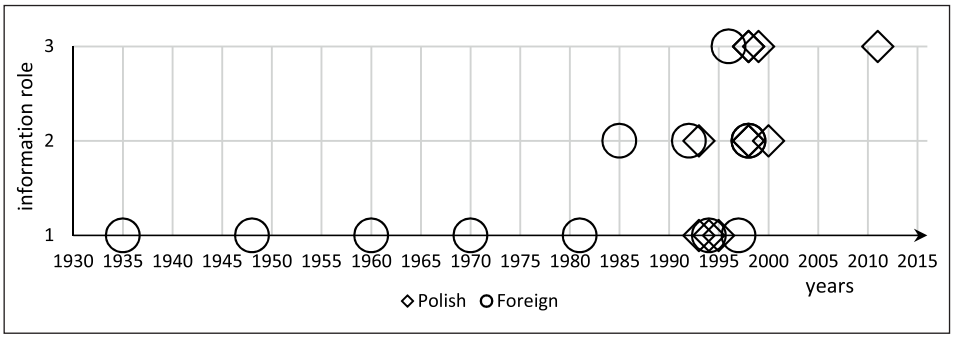

Chart 1. Information resource role in logistics definitions over time
Source: (own work)

3. Information logistics

Chaberek (2014, p. 6) defined logistics as a "process, which provides services of any rational activity of human being, aiming to any given goal, and which consists in providing required resources in right place and time, in right quantities and of right quality and for right price in such a way, that the whole scope of activities aimed to reach the main goal is realized in effective, efficient and beneficial way". This definition covers the subject of logistics, which are all real economic resources, where logistics activities are oriented on ensuring the aforementioned resources, and praxiological conditions: effectiveness, efficiency, and beneficialness have to be fulfilled. Chaberek's definition can be used for defining information logistics – it is a process, which purpose is supporting any rational human activity, aimed at the realisation of any objective by ensuring information resources in the right place and time, in the right quantity, right quality and at the right price, so that all activities realising the main objective were performed in an effective, efficient and beneficial way. As stated in the beginning of the article any rational human economic activity processes need resources for its smooth operation. Information logistics as a supportive process helps to realise supported activities objectives by ensuring:

– right information – according to recipient demand,
– in the right place – where is expected to be found,
– in the right time – delivered not too late and not too soon,
– in right quantity – avoiding information noise and information gap,

– in right quality – comprehensive, accurate, clear, consistent, concise and in a convenient format,
– at the right price – as agreed with the recipient.

This process has to also meet praxiological conditions:

– effectiveness – by helping to realise supported process objectives,
– efficiency – by not letting the operation costs to exceed its effects,
– beneficialness – by using resources, which values are higher than their prices.

Above definition can be successfully applied in organizations to improve their basic processes performance by efficiently supporting them with information logistics.

Conclusions

Economical activities are continuously fulfilling people's needs and they are running as a processes in business organizations. For their constant operation they need all required resources, including information, which role in logistics definitions has increased over last century to a status of independent subject. Information logistics as a supportive process is capable of proper provisioning this valuable strategic resource.

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Corresponding author

Michał Oleszczak can be contacted at: mol@umk.pl

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Adam Wieczorek

Department of Business Economics, Faculty of Economic Sciences, University of Warmia and Mazury

THE INFLUENCE OF SELF-DRIVING TRANSPORT VEHICLES ON THE FIELD OF LOGISTICS

Abstract

The demands for transport are presently at quite high level. There are few transport branches which are used now, but in fact the road transport is the one used most. Transport actions are ought to deliver goods from point A to point B, and thus they influence the goals of logistics referred as 5R. Providing the right resource, in right place, on the right time, in right cost and in right quality, depend mostly on transport services. Using of the autonomous technology in transport allow to achieve better results in the field of logistics services. The purpose of this article was to present the benefits of autonomous transport and its influence on the logistics. Theoretical considerations were summarized with conclusions, which may become during the deliberation about the usage of autonomous transport vehicles.

Keywords: logistics, autonomous technology, autonomous vehicles

Introduction

In a very simple way, logistics actions goal is to ensure the right resources for enterprise to enable the production of goods or services. One of the key activities of logistics is the transportation process, which aim is to deliver resources to enterprise and of course finished goods for the final client. In that way, it is one of the most important elements of logistics service. Transport is a crucial thing as it influences every goal of the 5R rule[1]. Right now, the road transport is the most popular branch of transportation on the whole world (Łacny, 2008).

[1] 5R rule as the purpose of the logistics which is providing the right resource, in a right place, right time, with the right quality and right cost.

As the transport processes are important it is quite valid to improve them, as it might lead to improvement of the logistics service. One of the possible ways to make transport better is autonomous technology. This relates to the purpose of the article which is to indicate the positive aspects of autonomous technology usage and its influence for the logistics. Article has review character, based on the logistics literature and many internet sites about modern autonomous technologies in transport.

1. Transport and logistics

All the human actions require some skills and right resources. Every rational and purposeful require specific materials (resources). One activity will be possible to make when the actions from the field of logistics service are made properly. Mirosław Chaberek defines logistics as a process which aim is to serve every rational activity of human, which goal is to fulfill the specific purpose by providing the right resources in the right spot and time, and in the right quantity and quality, with the right cost, in a way that all activities of accomplishing the main goal are realized in an effective and beneficial way (Chaberek, 2011). The other definition was created by the Council of Logistics Management which states that logistics is the planning process, realization and control of effective of resources flow, along with information in the terms of economy, from the place of origin up to the place of consumption (Coyle, Bardi, Langrey, 2002). On the basis of such definitions it is possible to state that no actions, especially in the field of productions is possible without the logistics service. Additionally, it is important to present the goals of logistics which are per the 5R rule, which concern the ability to ensure (Chaberek, 2002):

– right resources,
– to the right place,
– in right quality,
– on the right time,
– with the right quantity.

In this case the word "right" concern the needs of main process, as it is the main purpose of when, where and in which quantity there will be demand on right resources (fig. 1).

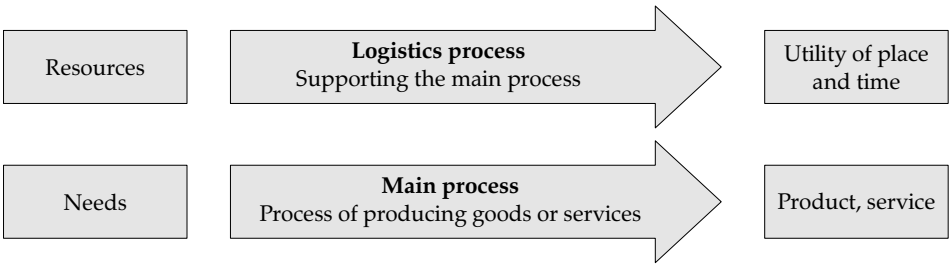

Figure 1. Parallel process of main and logistic process
Source: (Chaberek, 2002)

One main process may be serviced by one or more logistics processes, per the fact of how complex the main process is and how much resources does it require. When it comes to the goals of the logistics and the definitions it is also important to reveal its two functions which are: integration and maintenance. Logistics activities are crucial aspect when it comes to the integration of resources flow processes. The integrative function has two spheres. One concerns the integration between many processes supporting the main one. This sphere relates to connectors between enterprises which are responsible for various actions within the system of logistics support. The other sphere is about integration between suitable elements of logistics and main processes. Despite the second sphere it is important to maintain right coordination. The purpose of this timing is to control that the right logistics processes support the right main process. The coordination is responsible for the regular course of the production process, and therefore may influence the level of customer service or the prices of final goods (Chaberek, 2002). The other function of logistics concerns the service of main process. It is the essence of every logistics processes, because there are no of them which are servicing. In situation when main process (production) is ought to produce some goods, the supporting process (logistics) must provide all the essentials resources in accordance to the 5R rule (Chaberek, 2002).

Every production or service activity will require the right amount of service from the logistics processes. It is worth to mention that the quality and efficiency of logistics processes will have impact on many effects which relate to main process such as: quality of the final goods, cost or time of production. In that way, it is important to understand the value of integrative function of logistics. Jan Długosz claims that logic relations are main purpose of modern logistics (Długosz, 2000). Such opinion should be complemented with the fact that logistics activity is conscious and purposeful. It relies on the realization of specific goals, using of appropriate technical, infrastructure, organizational and legal means, while using at the same time selected methods through the activities of relevant logistical process engineers. Overall these actions and means are specified as logistics support system (Chaberek, Karwacka, 2009). Specified logistics support system allows to act and use the specifics techniques and means which allow to achieve the goal of ensuring the right resources to carry out the main process. Logistics support system (LSS) consist many components which are to support the course of main process. The actions which takes place within LSS starts with choosing the technique of production, determination of the size, up to the utilization actions of used goods. In a shortcut, it is possible to designate the main actions of LSS (Chaberek, 2002):

– providing of necessary equipment, machines and devices,
– providing the access to the required maintenance services,
– providing all the resources.

All the actions of LSS which are necessary for the production highlight one of the very important activities of LSS which is transport. The transport processes relate to the physical movement of the goods, people or waste. This activity is directly responsible for the situation when the specific goods or resources must be delivered for right place in right time. The actions from the field of logistics in

transport concern most of all the decision about the right branch of transport in accordance of what should be moved. In such case the decision about the branch of transport may affect indirectly the time, quality and the cost of transportation, so it is possible to state that transport affects all the purposes of the logistics (5R) (Chaberek, 2002). The choosing of way of the transport, technology of loading and unloading and the protection of the commodities during the movement will determine, how effective the logistics purpose will be fulfilled. In long time range it will influence the quality of the final goods, price of availability for the final clients. The transport actions are also one of the biggest costs from the overall logistics costs, so it is important for these actions to be done as efficiently and effectively as possible.

2. Self-driving vehicles in logistics

Autonomous vehicles, or in some cases the vehicles which do not require the presence of the driver existed in many thoughts and plans of automotive industry, even in the 50s of 20 century. Despite many of technological limitations, this idea was developed up until now, where we can for the first time present the fully autonomous vehicles. Self-driving car were defined as vehicles which do not require the direct actions of human such as steering, accelerating or braking (NHTSA). Per the institution of National Highway Traffic Safety Administration, in autonomous truck the driver is not obliged to observe the road for the whole time during the "auto-pilot" mode. Of course, the definitions are clear in a fact that such vehicles are not automatic driving cars, which relates to the fact that the drivers should be present in the cabin of the car or truck. Presently the technology is so advanced that vehicles may transport things on chosen routes without the activity of drivers. First of the real used autonomous trucks were presented in United States within the mines (Pauvre, 2016), and some of them can be legally used on choses routes with some of the states (Kostecka, 2016). Such examples can be also found within the Europe, such as convoy of autonomous truck within the European platooning challenge held in 2016 (Budzeń, 2016). Every of the experimental routes granted positive outcomes in way of: greater safety, lesser usage of fuel, faster and more efficient performing of transport processes. Safety of the driver and transported goods is a crucial thing, when it comes to the fact of providing the resources in right place on the right time, and in right quality. Some studies show that 90% of accidents are caused by the human mistakes. When it comes to the autonomous trucks, they have better reaction time, and many algorithms which adjust the steering of the vehicle for the weather conditions, by steering the vehicle smarter and safer than humans, and eliminating the fatigue (Bosch-Studie, 2012). Usage of the autonomous driving cars may also reduce the number of vehicles on the roads which can affect the lesser negative influence on the environment. In addition, the more efficient steering of the vehicles is characterized by lower fuel consumption, which stands for less cost and less negative impact on environment (Kückelhaus, 2014). Better performance of the autonomous vehicles in comparison to the "regular" ones may be achieved by the system of internal communication between them,

what allows them to avoid the congested roads, and to adjust the speed within the convoys. Such actions indicate the savings of around 15%. Additional barrier is the work time of the drivers, which could be eliminated by usage of autonomous vehicles, adding the savings to the overall level of 40% (Kückelhaus, 2014). It is also worth of mention that in case of autonomous vehicle the driver becomes the passenger, who is involved in steering only in some parts of the journey, and for the rest of the time he or she can do something else. Such examples of benefits make one to reflect, and point out the positive implications for logistics, as a way of providing the resources in accord to the 5R rule.

Usage of the autonomous transport system does not need the be limited only for the long roads. Such technology may be also used for the improvement of internal transportation of enterprises. Usage of advanced sensors and specifically programmed algorithms of GPS for the warehouse devices. Vehicles which are used in warehouses, based on autonomous system are good not only for the transportation of materials but also for loading, unloading and completion of orders. These systems influence on the improvement of safety and efficiency of warehouse processes. Many of devices can move within the warehouses, causing no danger for working people and predicting their routes to be faster and more efficient. Such example could be the Knapp cart vehicle (*KNAPP Logistics Automation Open Shuttle AGV*, 2013). It is of course one of many examples, and the others are adjusted to the size of warehouse and other needs. The popular forklifts were also upgraded with autonomous technology (balyo.com). From autonomous palette carts up to system overlays, which are meant not only to move the goods from point A to B but also automatically identify pallets or goods, for the work within the warehouse to be made faster, more efficient and safer, without any goods damage. Such improvements allowed the creation of special devices which automatically collect the specified goods and transport them or even unload at the chosen point. In a large scale, such devices make all the warehouse operations easier and allow for them to be conducted faster. These examples were proven and effects of use are: better safety within the warehouse and improvements in making such processes. Autonomous vehicles can improve also the outdoor warehouse processes. They are used within the yards, airports or harbors. Many of the vehicles in such places are a threat for people working there. Autonomous technology used in these places proven more level of safety, less damaged cargos and faster conducted processes of loading and unloading (Kerner). In the airports or harbors, special vehicles were used for the transportation of containers, which can be exampled by the container terminal in Altenwerder in Germany. Container movement in this place is almost whole automatic, conducted by 87 driverless vehicles. Such solution granted faster movement of cargos, and improvement of effectiveness of container terminal (*SCA – Preventive maintenance at the world's largest container terminal*, 2009). Like this, there are also vehicles used in big airports granting similar improvements. When it comes to the improvement of loading and unloading processes, it is essential not to forget about long distance road transportation. Road transport is one of the most popular transport branches, which are used because of its high availability, well developed infrastructure and big level of flexibility. This is one of the biggest part

of transport when autonomous technology may be used for improvements. Such system can affect the safety of the drivers, the cargo and the whole time of transportation. Right now, the usage of fully driver-less vehicles is not allowed, but in many places, there were made tests in which driver was present only in the first truck of convoy. Such actions were limited to the driving on the highways and expressways, both in the USA and Europe. Used technologies allowed to get results, such as reduction of the crashes, reduction of the fuel consumption of 5–10% which relates to the costs of transport services (Green Car Congress, 2014). As the final stage of providing the right resource for the client in accordance of 5R rule, is the stage called "last-mile transport", which is delivering the goods or resources directly to the client or enterprise. Plans are to develop new system which aims to help the delivery for people. Such system is planned to have vehicles which are used for delivery services and will inform about the need of another loading or, these vehicles will do such thing automatically. Collection stations are now also popular. They are based on autonomous technology. It is possible to grant Polish example which is "Paczkomaty", which allow us to collect our goods at the right place and time for us. The plan is, then in the future such parcels will be small enough to move from place to place, when someone wants to receive the goods. Such thoughts are to provide faster and more efficient process of providing the right resources along with the right price (Kückelhaus, 2014).

Given examples are the real source of possible benefits of using the autonomous transport vehicles. Right now, we have so many improvements for logistics, and positive effects of using such technology, despite technological and law limitations. In the future, it is very likely that we will have first routes which will be meant only for the autonomous transport, making the services for 24 hours in every day, to provide the right resources per the 5R rule.

Conclusions

The autonomous vehicles will be the part of another industry revolution in the future. Usage of the autonomous transport, and in the future the automatic transport will change the outlook and functioning of many human aspect of life. For sure it can be stated that this form of modern transport will affect logistics. Right now, we can only ask questions "when" the autonomous vehicles will be commonly used. Autonomous transport as a part of logistics support system is very important part of logistics services. Providing the right resources according to the 5R rule, when using autonomous transport may be done faster, more effective, without any worries about the cargo, and without any mistakes during the loading process, at exact moment of demand. Autonomous vehicles are also connected with less costs for the service, what allows the enterprises for further development to be able to provide goods and services. Among many benefits of autonomous transport within the logistics service, it cannot be forgotten about some problems of moral and law issues. If such vehicles are ought to function without driver participation, who or what will be responsible in case of any crash. There are many dilemmas

about safety on the road when it comes to the autonomous vehicles, even despite the fact of testing and researches proving better safety on the roads. The moral and law responsibility can be the cause to write another article. Right now, usage of autonomous vehicles results in only positive effects, and improves the logistic services.

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Corresponding author

Adam Wieczorek can be contacted at: adam.wieczorek@uwm.edu.pl