LogForum

> Scientific Journal of Logistics <

http://www.logforum.net

e-ISSN 1734-459X

Scientific journal, issued quarterly
since 2005

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Volume 7 2011

Issue 1

January - March 2011

Issue 2

April - June 2011

Issue 3

July - September 2011

Issue 4

October - December 2011

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 1
No 1

http://www.logforum.net

PRODUCTION SYSTEM VIRUS ANALYSIS TOOL (PSVA) - PROBLEMS IDENTIFICATION AND ANALYSIS FRAMEWORK - CASE STUDY

Piotr Cyplik, Lukasz Hadas

Poznan University of Technology, Poznań, Poland

ABSTRACT. Background: Identification and analysis of problems occurring in complex machine-building company production systems is a very crucial stage in the process of improving these systems. Effective production systems nowadays are a key to the success for this type of companies.

Material and methods: On the basis of production system problem identification and analysis tools known from the subject literature (among others ASIS model, Ishikava (fishbone) diagrams, impact wheels, current reality tree, risk assessment mapping tools (FMEA), cause and effect diagrams) the authors of this paper proposed their author's identification and analysis framework of problems occurring in machine-building enterprise production systems. The proposed tool is a specific hybrid of solutions known from the literature. The model has been developed and verified in a running business conditions.

Results: Author's tool has been successfully used within the frames of a project aimed at improving the production system of one of the Polish biggest machine building's sector manufacturer. Problem identification and analysis framework of production systems in machine-building companies developed within this project has been called Production System Virus Analysis (PSVA) for the reason of results presentation specific character. In this paper basic assumptions and methodology of the tool developed by the Authors have been included. Additionally, in the practical part the Authors present an example of PSVA adoption for problem identification and analysis in the production system of one of the Polish biggest machines building company.

Conclusions: Every organization needs to use a proper combination and selection tools, methodologies and techniques for identification and analysis of their own problems on the path to implementation of improvements. The authors experience show that the appropriate tool: able to identifying core problems, indirect causes and symptoms, significantly improve the efficiency of long-term process of rebuilding production and logistics systems.

Key words: production system analysis, machine-building company, problems identification, ASIS model.

INTRODUCTION

An effective production system can be perceived as one of the main elements of competitive edge of manufacturing enterprises. Efficiently working production system underlie effective functioning of a manufacturing enterprise itself as well as functioning of a supply chain, which the enterprise is the part of. Unfortunately, not all enterprises can recognize their production systems as an effective one so they undertake some permanent activities correcting actual state. The process of improving such system is complicated and difficult - as a rule. Heterogeneity and diversity of challenges appearing in the enterprises' production systems heighten difficulties with identification of key problems determining effectiveness of whole system. A useful tool in identifying and analyzing such problems

Citation: Cyplik P., Hadas Ł., 2011, Production system virus analysis tool (PSVA) - problems identification and analysis framework - case study. LogForum 7, 1, 1
URL: http://www.logforum.net/vol7/issue1/no1
Accepted: 14.01.2011, on-line: 21.01.2011.

can be the author's Production System Virus Analysis framework - a specific hybrid of solutions known from the literature.

Main objective of the authors performance was creating a tool to identification and analysis of a production system' problems which enables indicating proper correcting activities to the improvement of financial condition of the enterprise through the better use of its potential.

THEORETICAL BACKGROUND

Improving of production system brings many difficulties. Finding answer to questions: which way should the enterprise follow?, which model of production system to choose?, which solution of a problem will bring the best effects? is not easy. In the literature of subject, one can find many various hints, case studies as well as recommendations of the "best solutions" e.g. Cochran and Kaylani (2008), Umble at all. (2005) etc. The choice of one solution, adjusted to a specificity of the enterprise being studied, which is to support transformation of a current system into effective production system - brings many problems. According to guiding principles in the literature, the first step to be taken in any operation aimed at improvement is to understand a business process, which is to be improved. One of the tools used to understand a business process is a process mapping, which serves several purposes. Firstly, it allows good understanding of the elements of a process - actions, results and participants. Secondly, it helps to define a process range and separate it from adjoining processes. Thirdly, it offers a point of reference against which a range of improvements is measured (Bozarth and Handfield 2006). Apart from the process mapping, companies must apply more formalized procedures in order to be certain that a problem has been diagnosed correctly. Root Cause Analysis is a procedure, which first involves brainstorming, which is meant to identify any potential causes of problems, and then collecting data and analysing them in an organized manner, gradually narrowing down the area of interest to a few root causes. Causal maps are one of the tools for the root cause analysis. In the operations management literature, causal maps are known under many names, including Ishikawa (fishbone) diagrams, impact wheels, issues trees, strategy maps, risk assessment mapping tools (FMEA) and, cause and effect diagrams. Operations management researches often use causal maps as a key tool for building and communicating theory, particularly in support of empirical research (e.g. Hays and Hill 2001). The only widely accepted approaches for capturing cognitive data for a causal map are informal brainstorming, formal brainstorming (Pande and Holpp 2001), and structured interviews (Chmeilewski et al. 1998).

Tools for root cause analysis

The Ishikawa diagram, also known as the fishbone diagram and root cause analysis, is a simple causal map developed dr. Kaoru Ishikawa, who first used the technique in the 1960s (Enarsson 1998, Kelley 2000). The basic concept of the Ishikawa diagram is that the basic problem of interest is entered at the right of the diagram, at the "head" of the main "backbone." The possible causes of the problem are drawn as bones off the main backbone. The categories often used as a starting point include materials, machines (equipment), manpower (people), methods, Mother Nature (environment), and measurement. Other causes can be chosen as needed. Brainstorming is typically done to add possible causes to the main "bones" and more specific causes to the "sub-bones." This subdivision into ever increasing specificity continues as long as the problem areas can be further subdivided. The maximum practical depth of this tree is usually about four levels. As an Ishikawa diagram becomes more and more complex, it becomes more difficult to understand and use. Most quality management authors recommend using brainstorming methods to generate Ishikawa diagrams (Pande and Holpp 2001).

The impact wheel is a simple structured brainstorming approach designed to help managers fully explore the potential consequences of specific events and to identify consequences that they might

otherwise fail to anticipate. The facilitator writes the name for the change, or event, in a circle in the centre of the whiteboard and then engages the group participants in a discussion of three points.

- The inferences - The "impacts" of the change (drawn like spokes of a wheel).
- The probabilities - The likelihood (probability) for each impact.
- The implications - The cost and benefit of each impact.

The group then focuses on each impact and repeats the process.

Consulting firms often apply a causal mapping tool called an issue tree analysis. The approach helps break down an issue (a problem) into its major components (causes) in order to create the project workplan (Miller 2004). The approach usually puts the main issue on the left and then disaggregates the issue into smaller issues on the right.

Causal mapping is also a key tool for risk assessment and management (Hodgkinson et al. 1996), and is known by several names such as fault tree analysis (Jetter et al. 2001), event tree analysis (Kumar, 2000), and Failure Mode and Effects Analysis (FMEA) (Franceschini and Galetto 2001). These maps are used to provide a systematic method for identifying all types of potential failures, their potential causes, and their consequences. These methods are beneficial in the design of a product and a process, in improving understanding of the system, focusing risk mitigation efforts, and identifying root causes of failures. The most popular of these methods in practice is Failure Modes and Effects Analysis (FMEA), which is a systematic way of looking at process and product failure modes.

A cause and effect diagram is a causal mapping tool for quality improvement and plays a prominent role in quality management programs such as the Six Sigma program (Pande and Holpp 2001). A cause and effect diagram is an extension of the Ishikawa diagram and is not constrained to the "fish" diagram (e.g., does not require any pre-defined structure and does not use the "M" alliteration to identify potential causes) and uses ovals to represent variables. Many popular books (Pande and Holpp 2001) suggest asking the "five whys," which ask "why" five times in order to uncover the root causes of a problem. Goldratt's "current reality tree" (Goldratt 1994) is a cause and effect diagramming technique that helps identify root causes. The diagram is unique in that allows for the creation of logical "and" between relationships leading into a cause. Most quality management authors recommend using brainstorming methods to generate cause and effect diagrams (Pande and Holpp 2001).

Theory of Constraint in root cause analysis

Management problems are too numerous and new problems always occur one by one in organizations. Moreover, some apparently intractable problems exist that cannot be solved by past experiences, making many managers worried about which solutions is effective. Therefore, an effective new managerial tool is urgently required to solve the intractable problems. TOC developed an effective technology for solving problems called the "Thinking Process", This process can be used as diagnosis in medical treatment, to list symptoms and identify "core problems", then to look for a new method of solving problems. Such new tools create the "Cause-and-Effect Diagrams" based on the pattern of establishing "Logical Trees", Three questions then are discussed: "What to change?" "What to change to?" and "How to change?" An optimal solution to these questions then is devised. The research and training of these technologies helps significantly in improving organization management. The Thinking Process consists of formal analytical tools that are designed to help people answer these three questions.

Such technology uses the "Current Reality Tree (CRT)" to diagnose causes or core problems, and the symptoms are called "Undesirable Effects". A common cause is deduced based on the pattern of observed symptoms. Up to a point, the diagnosis becomes easier to make with increasing numbers of symptoms, A single symptom can have many causes, but a pattern of different symptoms may have just one plausible cause. Rather than relying entirely on intuition to find the cause, a formal cause-and-effect map (Current Reality Tree) is constructed to identify a few core problems that can explain all of the observed Undesirable Effects (Noreen et. al. 1995). Another useful technique of root cause

analysis, which is a continuation of CRT, is "Evaporating Cloud" - a specific technique to identify the assumptions underlying the apparent conflict and break the deadlock. The above techniques described by Goldratt (1994) have both found their place in the tool designed by the Authors of this paper.

BRIEF METHODOLOGY OF PRODUCTION SYSTEM VIRUS ANALYSIS (PSVA)

PSVA is a practical method of identifying and analysing problems, which occur in a production system. The final result of realizing the subsequent stages of such analysis is creating the Production System Problem Virus. The virus attacks healthy tissues of a production system and causes their death or transforms them into hybrids, which do not fulfil their basic functions they are supposed to fulfil. Diseased tissues cause malfunctioning of a production system, which translates into a decline in its effectiveness. Thus, clear identification of the problem virus becomes a key to its full elimination or at least restriction of its area of activity, which improves the effectiveness of the whole production system. PSVA methodology assumes the realization of seven subsequent stages:

1. Determining the objective of changes.
2. Determining the performance measures.
3. Appointing the team of experts.
4. Identifying problems.
5. Statistical analysis of identified problems.
6. Current state analysis (ASIS).
7. Designing the production system problem virus.

All these stages will be shortly elaborated on. We now short elaborate on each of these stages.

Determining the objective of changes

Problem analysis is usually the first stage in the realization of a production system streamlining project, and that is why a clear definition of the objective of changes becomes an essential element of the PSVA framework application. The objective should be clear and comprehensible to all managers and employees in a company.

Determine the performance measures

Objectives of a streamlining project should be measurable. It is thus essential to evaluate the advantages resulting from the implementation of improvements aimed at increasing the effectiveness of a production system in a selected company. At this stage main performance measures of a production system should be selected, and they will constitute a measurable effect of improvements. A large number of measures may pose certain problems. However, top managers are expected to manifest an ability to take right decisions and select maximum 10 main performance measures in a production system, which will reflect a current state of affairs as well as future changes in the widest context possible (compare: example in chapter 4.2).

Appointing the team of experts

A team of experts should be appointed during direct workshops based upon brainstorming methods in order for them to identify and analyse problems in a production system. Such team should include employees directly involved in a production process, as well as employees from the auxiliary areas. The wider this spectrum is, comprising a wide area of company's operation, the more effective the problem identification process will be in a production system. Covering all areas of the company's operation with team members' competencies guarantees the identification and analysis of problems

appearing on the border of a production area and other functional areas in a company. There is a possibility of further division of the team of experts into smaller groups in order facilitate the conduct of problem identification workshops based upon brainstorming methods.

Identifying problems

Identifying problems in a production system within the PSVA assumes two stages:

1. Workshops with experts where problems in a production system are identified with the use of brainstorming methods. During such workshops commonly known tools, such as Ishikawa diagram, impact wheel tools, etc. can be used.
2. Drawing and analysing maps of processes with the use of well known tools for creating such elements.

On the basis of the identified problems where both above-mentioned practices were applied, the Team of Experts should determine the influence of each identified problem on the objective of the project of changes and its parameters described at the first two stages of the PSVA. It is suggested that relative dispersion rate should be applied in order to clearly determine the experts' agreement.

Statistical analysis of identified problems

A statistical analysis of identified problems is a stage where problems reported at the workshops by the Team of Experts are subject to grouping and a preliminarily analysis. What is analysed here is the influence of the defined problems on particular parameters of a success determined within the second stage of the PSVA. In such analyses various statistical tools are applied, such as histograms, bar charts, etc. Such prepared data are used to realise the next stage, which is a current state analysis and finding root causes.

Current state analysis (ASIS)

The main objective of this stage is to find root causes of a current state of affairs leading to low effectiveness of a production system. According to PSVA methodology, the material gathered at the previous stages is analysed here. For the purpose of this task modified methodology of "Current Reality Tree" analysis has been applied. This analysis was described in "It's not luck" by E. Goldratt (1994). The basis for establishing relationships among identified problems within "Current Reality Tree" is, to a great extent, the 5 Whys method described in "The Toyota Way" by J.K. Liker. When analysing the current reality tree downwards one starts with the most general problem and through why-questions comes to the main causes of such a state of affairs. An upwards analysis enables the following statement: if I solve the major problem a problem, which arises from it, should solve itself too.

The production system streamlining process must be based on facts, not opinions. Although members of the team may seem to have discovered the root cause of a problem, they must verify their views before they proceed to design a solution. A real data analysis based on tools including correlation diagrams, control sheets, Pareto analysis, etc. allows approval or rejection of the diagnosed root cause.

Designing the production system problem virus

The last stage of the PSVA is designing the production system problem virus. It consists of a central part called the nucleus and an external and internal coating. The nucleus reflects root causes identified and confirmed through the data analysis during the previous stage. In the internal coating there are major problems, which cause a decrease in the effectiveness of a production system of a company. The external coating is made up of protrusions, which symbolise symptoms of problems,

which appear in a production system. Picture 2 in chapter 4.7 shows an example of the Production System Problems Virus.

THE EMPIRICAL VERIFICATION OF THE PSVA

The framework of identifying and analysing problems in a production system proposed by the Authors for machine building companies has been implemented within a production system streamlining project by one of the main Polish machines building manufacturer. The production system in the analysed company is in many aspects a typical representative of a machine building company operating in a traditional way. The production is realised in a standard way typical of heavy industry: 1. forging/casting/etc. - 2. treatment - 3. assembling. An expected result of the PSVA application was identification of the key problems in the production system and then their elimination.

Defining the objective

The main objective of the streamlining project in the analysed company was to design solutions whose implementation would improve the effectiveness of the production system. It is required that the concept of improvement of the production system's effectiveness should be defined first. Thus, an effective production system will be understood as practical activity connected with planning, current steering and control of a number of finished products, works in progress and raw materials, as well as an extent to which resources are used to meet customers' demand, minimizing production costs, delays and stock, along with maximising productivity and, indirectly, maximising profits and return from the invested capital. A crucial element of an effective production system will be eliminating a waste of time and resources and incorporating quality into systems of a workplace.

Determine the performance measures

From among many performance measures used to evaluate the streamlining in the production system of the analysed company nine were selected. They were not chosen at random, however. This choice was dictated by a wide range of the company's operations, which is covered by these measures. Among others, there are financial measures, cost measures, safety at work measures, innovation measures and customer service measures. The group of selected measures comprises:

1. DDT - Dock to Dock Time - shows how long the stock is kept in the stream. The time is measured from the moment raw materials are delivered to a plant, through the time they go through production until a finished product is delivered to a customer.
2. OEE - Overall Equipment Effectiveness - a basic measure applied in TPM (Total Productive Maintenance) implementation, which is the outcome of three measures: availability, usage and quality.
3. VDP - Vendor Delivery Performance - informs of the percentage of order items realised in accordance with the first confirmed delivery date and in the full quantity ordered.
4. IFG - Indicator of Faulty Goods - shows the percentage of faulty items of goods against the overall volume of production/sales within a given period of time.
5. II - Indicator of Implementation - describes effectiveness of a company within the implementation area. It is understood as the percentage of approved streamlining implementations per a time unit.
6. EIPFC - Effectiveness Indicator of Production Flow Control - a ratio of the quantity of final products manufactured in a sequence, which complies with MSP to the overall number of final products, manufactured within a specified period of time.
7. IHSW - Indicator of Health and Safety at Work - shows the percentage of persons who suffered an accident on the premises of the company in the last quarter of the year.

8. SC - Stock Coverage - informs of a number of days covered by the stock of finished products, works in progress, materials and raw materials.
9. SPP - Sales per Person - describes a monthly value of stream goods sales per an employee in the production area.

Appointing the team of experts

In order to identify and analyse problems in the production system of the analysed plant at direct workshops based upon brainstorming methods the Project Team was appointed and then divided into three groups:

- Steering Committee - the Company's Board consisting of three members
- Core Team - consisting of twenty key employees of the company who are in charge of the main and auxiliary processes realised within the production area and incorporating among others: Production Manager, Innovation Manager, Sales Manager, Logistics and Maintenance Manager, Foundry Manager, Treatment Manager, Quality Control Manager, Service Manager, Purchasing Department Manager, etc.
- Support Team - consisting of eight employees in charge of the auxiliary processes and comprising among others: Chief Accountant, Human Resources Manager, Head of Stock Department, Head of Environmental Protection Management and Safety at Work Team, etc.

Each of the groups described above has an equal saying and influence on the final result of the works. The division into smaller groups enables effective conduct of workshops based upon brainstorming methodology. The full approval of decisions made by the other groups lies with the Steering Committee. Such selection of employees, which covers all areas of the company's operations, can guarantee identification and analysis of problems in the production system in a broad context of their effect on the overall performance of the company.

Identifying problems

A list of problems, which occur in the production system, was defined during workshops where brainstorming techniques were applied. Two analytical tools were used: the Ishikawa diagram and elements of the Impact Wheel. In the course of these workshops the Team of Experts identified 245 problems. For each problem a degree of gravity for the realisation of the project objective was determined (selected from the four options: very high, high, medium, low) according to the measures - compare chapter 4.2. On account of the right selection of employees for the Team of Experts the identified problems covered all the areas of the company's operations.

Statistical analysis of identified problems

All the problems reported in the course of workshops were analysed in greater details. Table 1 (below) shows the identified problems along with the differences in their influence on the measures (DDT, OEE, VDP, IFG, II, EIPFC, IHSW, SC, SPP) and a category of gravity ascribed to them (VH - very high, Hi - high, Mi - medium, Lo - low).

Table 1. Statistics of problems
Tabela 1. Statystyka problemów

	DDT	OEE	VDP	IFG	II	EIPFC	IHWS	SC	SPP	**Total**
VH	29	28	18	17	1	27	3	3	5	**131**
Hi	81	33	75	25	1	76	5	18	12	**326**
Me	21	9	18	9	0	15	2	3	3	**80**
Lo	0	0	1	1	0	0	0	0	1	**3**
Total	**131**	**70**	**112**	**52**	**2**	**118**	**10**	**24**	**21**	**540***

**The total number of problems presented in the table above does not correspond to the actual number of problems identified during the workshops where 245 problems were identified. The total number of problems in the table results from to the fact that the problems may affect more than one measure.*

According to the above table, important problems (60%) constitute the biggest group. The second largest group comprises problems classified as Very Important (24%). Other problems constitute only 16%. Thus, it is clear that classic Pareto principle was applied here - approximately 20% of all the problems were regarded as very important. The estimation shows that solving these problems will allow realisation of 80% of the assumed effects.

Current state analysis (ASIS)

The process of documenting the current state of affairs starts with identification of a major problem - ineffective production area. The reason for this problem in the analysed company lies in an ineffective casting system, ineffective treatment area and ineffective assembling of final goods. On account of quite an extensive current reality tree, each of the areas described above will be analysed separately below. Within the ineffective area of casting there are two main reasons for such a state of affairs - untimely production (delivery of rough castings to the final customer/untimely delivery of castings to the internal customer (treatment) and high production costs.

Untimely production results from:

- high defectiveness - production recoveries after failures increase defectiveness,
- frequent failures and shutdowns - failures and shutdowns delay planned production recoveries,
- incorrect planning of casting production - within planned castings certain constraints which result from the productive capacity of the Foundry are not always taken into account - a planning process depends largely on the experience of a planning officer,
- long decision loop - a complicated decision loop has its implications connected with a flexible decision making process, which can translate into delays in production,
- organisational and decisional chaos - has a considerable effect on a delayed delivery due an extended time for making necessary current decisions.

Considering the reasons for high defectiveness the most prominent ones are non-compliance with technological and quality regimes (this notion should be understood in a very broad sense, i.e. not only as typical technology but also as the best practice principle, strict compliance with safety at work regulations and the culture of work) and frequent failures and shutdowns. The reasons for non-compliance with technological and quality regimes are lack of motivation among employees, low awareness of work standards and, in some cases, incorrectly formulated technological regimes. The root causes for such a state of affairs are as follows:

- Lack of incentive scheme - incentive scheme is understood here as planned activities which aim at determining motivational components (reward and punishment system) for each workplace,
- Lack of clear standards of work - standards of work are understood here as a description of the best practice of performing particular activities for each workplace,
- Lack of training system - understood here as planned activity which leads to improving employees' qualifications.

While analysing the reasons for frequent failures and shutdowns the main reason seems to be lack of pre-emergency maintenance system, which results from "constant struggle for on-time deliveries" (making up for overdue production) and lack of ongoing inspection plans (machines frequently work until a failure occurs, which halts the whole production process). The reason for both above-mentioned effects is a permanent process of "extinguishing fires" (an ongoing increase in efforts to solve local problems). Extinguishing fires is essentially connected with an incorrect correlation of activities, which is regarded to be the next root cause. Local activities, which disregard the process as a whole from the supply-production-sales perspective, are considered an incorrect correlation of activities.

The next important element of the Current Reality Tree diagram is a long decision loop. Its basic reason lies in lack of confidence in employees and incorrect information flow. This lack of confidence in employees results directly from low awareness among employees as to standards of work. The problem of incorrect information flow, though, is closely connected with the root cause of incorrect correlation of actions and with unreliable data. It is non-compliance with procedures or lack of procedures that appears to be the reason for unreliable data. They result directly from two root causes, i.e. lack of clearly determined standards of work and lack of a real owner of an area/process. The latter root could be described as lack of a real host who has clearly determined rights and duties.

The reasons for high production costs, which can be reduced by implementation of organisational and maintenance changes are as follows:

- long decision loop - described above,
- high defectiveness - described above and
- organisational and decisional chaos - in general understanding it is a lack of decision syndrome, lack of clearly determined competencies and responsibilities.

Organisational and decisional chaos is caused directly by incorrect information flow, with the reasons described above. Another important reason for such chaos to arise is fuzzy boarders of responsibility, which stem from ambiguously defined competencies and a scope of responsibility for each particular workplace. Lack of a real owner of an area/process is regarded to be its root cause.

Picture 1 illustrates the analysed problems.

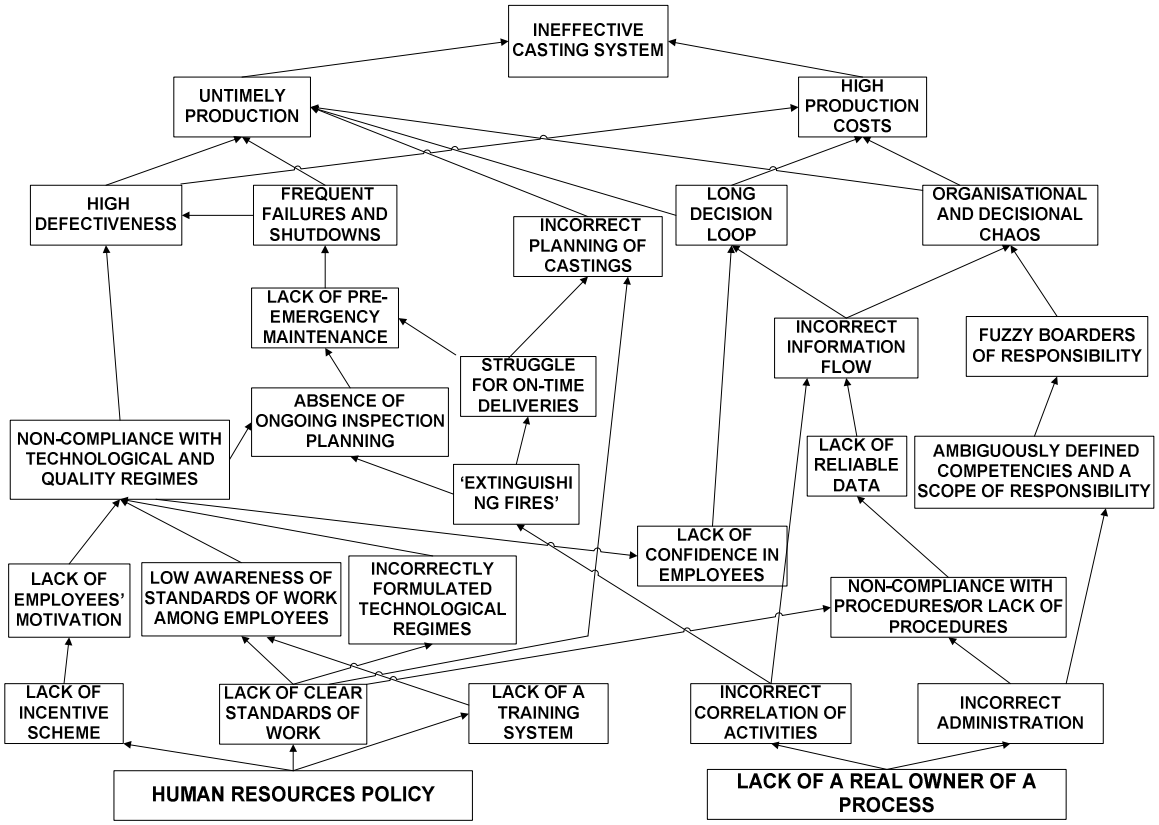

Fig. 1. Current Reality tree for the casting production area
Rys. 1. Reality tree w obszarze produkcji odlewów

The other two production areas in the analysed company (Treatment and Final Goods Assembling) have been analysed in a similar manner.

Designing the Production System Problems Virus (PSPV)

On the basis of the discussions resulting from the earlier stages the Production System Problem Virus of the analysed company was designed according to the methodology described in chapter 3.7 (see Picture 2).

The analysed company manufactures a wide range of products within its operations. At the same time, however, production is characterized by high costs. Apart from problems which strictly belong to a production area (high machine failure frequency, malfunctioning maintenance - renovation work and supply department which acts in emergency), the company must tackle a number of aspects linked with a company management process. These are primarily aspects of information flow, division of competencies (decision making process, hierarchy) and own workplace management. A remedy for the company's current condition is returning to old but still up-to-date good practice principles - an organizational order. Applying praxeology principles in company management will allow the company to raise effectiveness of the realised processes, while simultaneously understanding effects of both successes and failures of particular activities.

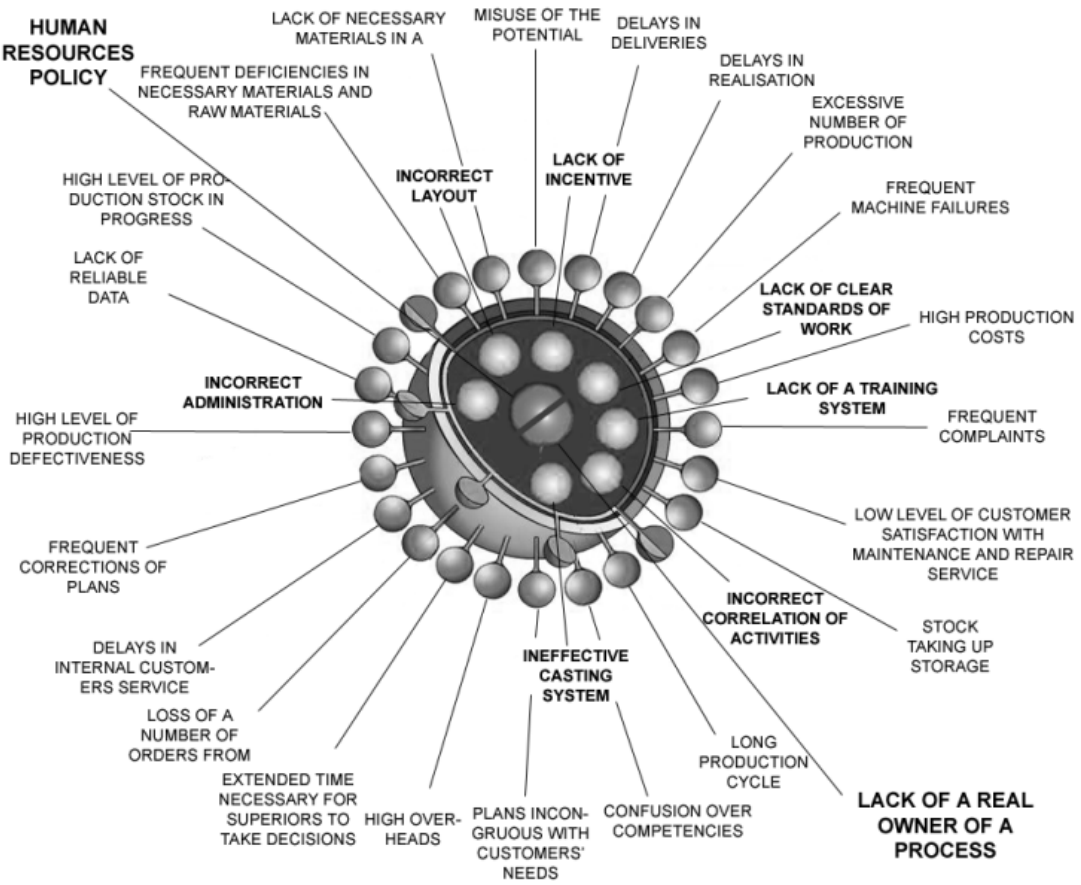

Fig. 2. The Production System Problems Virus of the analysed company
Rys. 2. Wirus problemów systemu produkcyjnego analizowanego przedsiębiorstwa

Destroying the virus, which is the reason for ineffectiveness of the production system, depends on destroying the reasons, which are its innermost part that is the root causes. They are:

- human resources policy,
- lack of a real owner of a process.

Production system streamlining projects should be directed mainly towards these two root causes. It will enable the elimination of major problems in the company:

- lack of incentive scheme,
- lack of clear standards of work,
- lack of a training system,
- incorrect correlation of activities,
- incorrect administration,
- incorrect layout,
- ineffective casting system.

and, consequently, the symptoms of the problems will disappear too.

CONCLUSION

At a cognitive level of the conducted research, the most important finding is an empirical confirmation of the view according to which well known methods of problem identification and analysis deriving from various branches and attitudes can be integrated. The framework of production system problem identification and analysis (PSVA) proposed by the authors is a compilation of the classic methods (Ishikava (fishbone) diagrams, impact wheels, current reality tree, etc.), which together with a different visualisation of results constitutes an interesting complementation of such methods. Originality of the proposed tool relies in an original selection of tools and methods known in the subject literature and a sequence of their use. Effectiveness of the proposed framework of production system problem identification and analysis has been confirmed by its empirical verification.

At a utility level of the conducted research the main result, which has been reached, is, apart from successful implementation of the tool in the environment of market economy, creating the methodology, which allows support of managerial decisions within the production system problem identification and analysis.

The authors of this paper consider it necessary to continue the works over improving the PSVA within the following areas:

1. improvement of conduct of workshops based on brainstorming methods with a view to better identifying key problems of a production system in analysed companies,
2. improvement of statistical tools used for the analysis of identified problems,
3. determining the next stage of the PSVA - designing the methodology of selection and deciding on the sequence of implementation of appropriate solutions which eliminate the production system virus in analysed companies.

The last area in particular poses a major challenge for the authors of this paper. The analysed company is currently carrying out implementation works aimed at improvement of the production system, which are a consequence of the applied PSVA.

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WIRUSOWA ANALIZA SYSTEMU PRODUKCYJNEGO (PSVA) - ZAKRES IDENTYFIKACJI I ANALIZY PROBLEMÓW - STUDIUM PRZYPADKU

STRESZCZENIE. **Tło badań:** Identyfikacja i analiza problemów występujących w złożonych systemach produkcyjnych branży budowy maszyn jest niewątpliwie bardzo ważnym etapem w procesie poprawy ich efektywności funkcjonowania. Efektywny system produkcyjny, jest postrzegany jako jeden z głównych elementów przewagi konkurencyjnej przedsiębiorstw produkcyjnych jak również łańcucha dostaw, którego ogniwem jest to przedsiębiorstwo. W związku w tym podejmują one permanentne działania korygujące obecny stan. Proces usprawniania systemu produkcyjnego jest z reguły skomplikowany i trudny. Heterogeniczność oraz różnorodność problemów występujących w systemach produkcyjnych przedsiębiorstw potęguje trudności z identyfikacją kluczowych problemów, które determinują efektywność całego systemu.

Metody: Na podstawie doświadczeń w usprawnianiu systemów produkcyjnych branży budowy maszyn oraz analizy znanych w literaturze przedmiotu narzędzi identyfikacji problemów (m.in. takich jak: model ASIS, diagram Ishikawy (tzw. „rybich ości", diagramu stanu obecnego, metody FMEA czy diagramu przyczynowo-skutkowego) autorzy artykułu zaproponowali własne złożone narzędzie identyfikacji i analizy problemów nazwane Wirusową Analizą Systemu Produkcyjnego (ang. Production System Virus Analysis - PSVA).

Rezultaty: Model został z powodzeniem użyty w ramach realizacji prac usprawniających system produkcyjny jednego z największych polskich producentów z branży budowy maszyn, przyczyniając się do poprawy sytuacji finansowej przedsiębiorstwa poprzez lepsze wykorzystanie jego potencjału. W artykule autorzy przedstawili ramową metodykę zastosowania opracowanego narzędzia a w części praktycznej przytoczyli studium przypadku jego użycia w rzeczywistych warunkach biznesowych.

Konkluzja: Każda organizacja musi używać odpowiedniej kombinacji narzędzi, metod i technik identyfikacji i analizy własnych problemów w procesie doskonalenia efektywności działania. Doświadczenia autorów wskazują, że odpowiednie narzędzie pozwalające na: identyfikacji problemów źródłowych i pośrednich oraz objawów znacznie usprawnia długotrwały proces przebudowy systemów produkcyjno-logistycznych. Pomocnym narzędziem identyfikującym i analizującym te problemy może być opisana na łamach tego artykułu Wirusowa Analiza Systemu Produkcyjnego będąca swoistą hybrydą znanych z literatury rozwiązań.

Słowa kluczowe: analiza systemu produkcyjnego, przedsiębiorstwo budowy maszyn, identyfikacja problemu, model ASIS.

WERKZEUG FÜR DIE VIRUSANALYSE DES PRODUKTIONS-SYSTEM (PSVA) - RAHMEN DER ANALYSE UND DER PROBLEMENIDENTIFIZIERUNG - FALLSTUDIE

ZUSAMMENFASSUNG. Hintergrund: Die Identifizierung und Analyse von Problemen, welche in den komplexen Produktionssystemen in der Maschinenbaubranche auftreten, gelten ohne weiteres als eine sehr wichtige Etappe auf dem Weg zur Verbesserung deren Effektivität. Ein effektives Produktionssystem ist einer der Bestandteile des Wettbewerbsvorteils, sowohl in Bezug auf die betroffenen Produktionsunternehmen als auch die Lieferketten, deren Bestandteile sie sind. In diesem Zusammenhang leiten sie permanente Korrekturmaßnahmen ein. Die Rationalisierung eines Produktionssystems ist in der Regel einer schwierige und komplizierte Aufgabe. Durch die Heterogenität und die Vielfalt der in Produktionssystemen der Unternehmen aufgetretenen Probleme steigt die Anzahl der Probleme mit der Identifizierung der Schlüsselprobleme an, welche die Effektivität des ganzen Systems determinieren.

Methoden: Aufgrund von Erfahrungen mit der Rationalisierung der Produktionsprozesse in der Maschinenbaubranche sowie der Analyse der Werkzeuge zur Identifizierung von Problemen, die aus der Fachliteratur bekannt sind (u.a. ASIS Modell, Ishikava Diagramm, Ist-Stand-Diagramm, FMEA Methode, Ursache-Wirkung-Diagramm), haben die Autoren ein eigenes komplexes Werkzeug zur Identifizierung und Analyse der Probleme, als Virusanalyse des Produktionssystems (Production System Virus Analysis – PSVA) genannt, vorgeschlagen.

Ergebnisse: Das Modell wurde im Rahmen eines Projektes zur Rationalisierung des Produktionssystems bei einem der größten polnischen Produzenten aus der Maschinenbaubranche erfolgreich eingesetzt. Dadurch hat es zur Verbesserung der Finanzlage des Unternehmens durch eine bessere Nutzung dessen Potenzials beigetragen. In dem Beitrag wurde eine Rahmenmethodik der Implementierung des erarbeiteten Werkzeuges dargestellt und in dem praktischen Teil ein Fallstudium dessen Anwendung in der Praxis aufgeführt.

Fazit: Jede Organisation muss eine entsprechende Kombination von Werkzeugen, Methoden und Techniken zur Ermittlung und der Analyse ihrer eigenen Probleme bei der Rationalisierung ihres Geschäfts anwenden. Die Erfahrungen der Autoren weisen darauf hin, dass ein entsprechendes Werkzeug, dass die Ermittlung von Kernproblemen sowie der Symptome den langfristigen Prozess der Umgestaltung der Produktions- und Logistiksystemen bedeutend rationalisiert. Ein hilfreiches Werkzeug, das diese Probleme identifiziert und analysiert, kann die in diesem Beitrag beschriebene Virusanalyse des Produktionssystems (Produktion System Virus Analysis – PSVA), welche als eine Art Hybride der in der Fachliteratur beschriebenen Lösungen gilt. Die Identifizierung und die Analyse der auftretenden Probleme in der Produktionssysteme des komplexen Maschinenbau-Unternehmen von Maschinenbau ist eine sehr wichtige Etappe im Prozess der Verbessung dieser Systeme. Ein gut funktionierendes System der Produktion ist heute der Schlüssel zum Erfolg für diese Art von Unternehmen. Aufgrund von Werkzeugen für die Identifizierung und die Analyse der Problemen der Produktionssysteme, die aus der Fachliteratur bekannt sind (u.a. ASIS Modelle, Ishikava (Fishbone) Diagramme, impact wheels, aktuelle Realität-Baum, Abbildungswerkzeugen für Risikobewertung (FMEA), Ursache- und Wirkung-Diagrammen), die Autoren von diesem Artikel vorschlagen ihres Autorenidentifizierung- und Analyserahmen der Problemen, die in der Produktionssysteme der Maschinenbau-Unternehmen auftreten. Das vorgeschlagene Instrument ist eine Hybrid der Lösungen, die aus der Literatur bekannt sind. Dieses Werkzeug wurde entwickelt und erfolgreich im Rahmen eines Projektes der Verbesserung des Produktionssystems eines der größten polnischen Maschinebauenhersteller verwendet. Die Rahmen für die Identifizierung und die Analyse der Problemen in dem Produktionssystem des Maschinenbau-Unternehmen, entwickelt im Rahmen diese Projekts, wurden Virusanalyse des Produktionssystem (Produktion System Virus Analysis – PSVA) genannt. Der Grund dieses Namens ist der spezifische Charakter der Präsentation von Ergebnisse. Die von Autoren entwickelten Grundannahmen und die Methodik des Werkzeugs, wurden in diesem Artikel präsentiert. Zusätzlich, im praktischen Teil, die Autoren präsentieren ein Beispiel der PSVA – die Verwendung für die Identifizierung und die Analyse der Probleme des Produktionssystems eines der größten polnischen Maschinebauenherstelle.

Codewörter: Analyse des Produktionssystem, Maschinenbau-Unternehmen, Identifizierung des Problems, ASIS Modelle.

Piotr Cyplik, Lukasz Hadas
Institute of Engineering Management
Poznan University of Technology
Strzelecka 11 St, 60-966 Poznan, Poland
e-mail: piotr.cyplik@put.poznan.pl
e-mail: lukasz.hadas@put.poznan.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 1
No 2

http://www.logforum.net

OPTIMISATION OF TRANSPORT PROCESSES IN CITY LOGISTICS

Zbyszko Pawlak, Maciej Stajniak

Poznan School of Logistics, Poznan, Poland

ABSTRACT. The problem of the rationalization of the flow of people and goods in urban areas is discussed in the presented paper. Due to the increasing traffic congestion, this is one of the most important problems of the effective city management, especially in line with the principles of the sustainable development. The paper presents local conditionings for urban agglomeration of Poznań, with particular attention paid to difficulties of the distribution of goods in urban areas. The available sources for obtaining the good practice for local authorities are presented, e.g. European projects like SUGAR Project (Sustainable Urban Goods Logistics Achieved by Regional and local policies).

Key words: city management, city logistics, sustainable development, distribution of goods in urban areas, flows of people and goods, road infrastructure in cities, SUGAR project.

INTRODUCTION

The condition of the effective city management by authorities is the very good knowledge of the specific issues connected with city logistics. For they are activities that require such connecting, channelling and controlling of flows of goods and services, necessary for the supply, cleaning and internal functional efficiency of the city, which causes the littlest loss of time and the limitation of the useless transportation of resources as well as the limitation of the emergence of bottlenecks and the congestion. The internally consistent (through good management) logistic system of city areas is such an arrangement, where the management processes of flows of people, goods and information are realized in accordance with principles of the sustainable development [Pawlak 2007] and fulfil the expectations of users of cities on an agreed level.

The following functional subsystems can be recognized within this system [Awasthi, Proth, 2006]:

- control of flows of goods and persons,
- collective and individual communication,
- storage of goods,
- transport of goods as well as media transmission,
- transport and storage of urban wastes.

The public administration acts as one of the main participants or coordinators in each of above-mentioned subsystems and realizes its functions through many institutions and offices. Additionally, the city logistics is a part of the economic policy of every country [Taniguchi, Thompson, 2001].

Citation: Pawlak Zb., Stajniak M., 2011, Optimisation of transport processes in city logistics. LogForum 7, 1, 2
URL: http://www.logforum.net/vol7/issue1/no2
Accepted: 14.01.2011, on-line: 02.02.2011.

The issues connected with the proper functioning of the city, the spatial concentration or deconcentration is also related to the spatial planning and the transport planning. The transport is one of basic factors determining the level of the economical development, which is also reflected in the theory of the regional development [Domańska, 2006]. An efficient transport system should be adjusted to the size, nature and spatial diversity of transport requirements in the discussed area and at the same time should be able to fulfil and connect all functions of the city [Tundys, 2008].

The aim of this paper is to diagnose the spatial transport problems of urban areas (based on the agglomeration of Poznan) to propose new solutions, which take into account a wide range of spatial, economic, environmental and logistical determinants.

The paper is of a theoretical and descriptive nature. The most recent specialist literature as well as the own knowledge and practical experiences of the authors were used in the process of the preparation of this paper. The method of the word description, expanded by the formalized mathematical expressions and graphic illustrations of communication routes of the urban agglomeration of Poznan was applied.

LOGISTIC RATIONALITY OF THE SUSTAINABLE DEVELOPMENT OF THE CITY

Each city is a concentration of the human population, environmental resources, different types of anthropogenic creations (including wastes and pollutants), economical operators and the whole range of social behaviours (from congestions up to crimes). The energetic, material, informational and financial flows connect and bind all these factors and create the systems of the logistic nature. They exist and develop always in a neighbourhood, which consists of different objects outside of this system, but having influence on this system and are influenced by it as well. These surroundings consist of collections of objects and relationships among them as well as their properties of economical and technical (infrastructure), social (level of awareness and incomes of inhabitants of urban areas) and ecological (environmental) nature [Pawlak, 2004].

The indicators of the sustainable development of cities, based on the American experiences and adaptations of the World Bank [World Bank, 1994] in the area of transport activities are focused on:

- Reduction of the use of a car per inhabitant,
- Increasing the loading share of the transport unit,
- Increasing the relative average speed of cars,
- Increasing the length of the separated bike paths.

The concentration of transport activities in urban areas (both freight and passengers' ones) causes the strong impact on the life conditions of the inhabitants as well as on functioning of the whole social-economic sphere. Approaching the rational policy of the sustainable development of urban areas, there is often a need for an indicator, which will allow to give some hints how to plan further activities e.g. logistic ones (which are based in big extend on the transport activities). There are a few most typical ones; among them so called the ecological footprint is one of the most often used. It is defined as an area required to satisfy the living needs of one person, the whole group or even the whole city. In terms of logistics of the city agglomeration [Estevan, Sanz, 1996] it allows, for example, to analyze the dimension of the supply of goods to the population. The equation used to calculate the annual ecological footprint for the urban mobility, required in this approach, looks like the following one in these conditions:

$$EF_i = \sum\left[\left[\sum EC_z EL_z D_{ij} Trip_{ij,z}\right] + L_z\right]$$

where:

EF_i - the annual ecological footprint made by *i* means of transport

EC_z - the energy consumed by the mean of transport *z* per km (GJ / km). Energy consumption (EC_z) is the energy balance of the whole transport cycle, calculated based on data concerning the energy consumption, manufactured transport units and the level of fulfillment of the loading unit.

El_z - the area of ecological land per GJ of energy of mean of the transport *z* (ha / GJ)

D_{ij} - the net distance between the locations *i* and *j*

$Trip_{ij,z}$ - the number of rides carried out during the year between the locations *i* and *j* using the mean of transport *z*

L*z* - the area of the land equivalent to the space occupied by the infrastructure of the mean of transport *z*.

Based on the conducted experiments and the calculations of the ecological footprint of urban areas in various European cities such as Barcelona, the constant (in practice) increase of its value is observed and this means that, there is an increase of the load of the natural environment as a result of the impact of freight transport activities. It can be presumed, that this is clearly resulted from a positive correlation between the increase of the supply of goods and an increase of the wealth of populations living in European cities.

This trend has undoubtedly increased substantially the transport congestion in recent years, causing the increase of the value of the ecological footprint (one of the Authors of this paper (Zbyszko Pawlak) is occupied with wider researches in different polish cities. The results will be presented in the separate paper). Its constantly growing levels are probably connected also with the increase of the frequency of the use of delivery cars and the elongation of transport distances. It is also undoubtedly caused by the changes in the residential structure of the urban areas in the processes of the suburbanization and at the same time in the processes of the allocation of industrial and services investments.

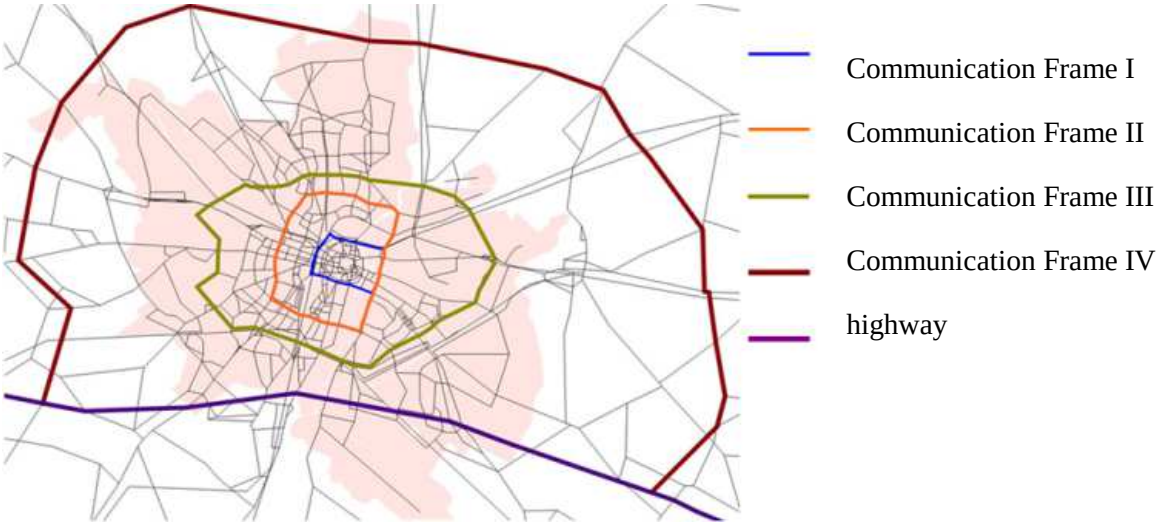
REASONS OF PROBLEMS CONNECTED WITH TRANSPORT STREAMS IN THE AGGLOMERATION OF POZNAN

Poznan is located on the axis of the cities of Berlin - Warsaw - Moscow, within the second Pan-European Transport Corridor linking Western and Eastern Europe. It is an important node connecting the key roads of international and domestic importance, and therefore is defined as a transit city.

The city of Poznan, together with adjacent areas, creates an agglomeration of a total population of approximately 850 000. In recent years, the trend of suburbanization can be observed. Due to that, the quantity of inhabitants of Poznan decreases and at the same time, the quantity of inhabitants of adjacent surroundings of the city increases. Therefore, the city authorities meet new requirements to organize the smooth transfer of people between their home and the place of a work, education, etc. The very important and still underestimated growing problem is associated with the efficient handling of the transport of goods needed to fulfil the needs of the city as well the efficient distribution of goods produced by companies located in this area. To meet these requirements, the new infrastructure investments are now performed or planned for the realization in the near future. Among others, this concerns the road network system, which is currently being developed as a framework layout of the main streets.

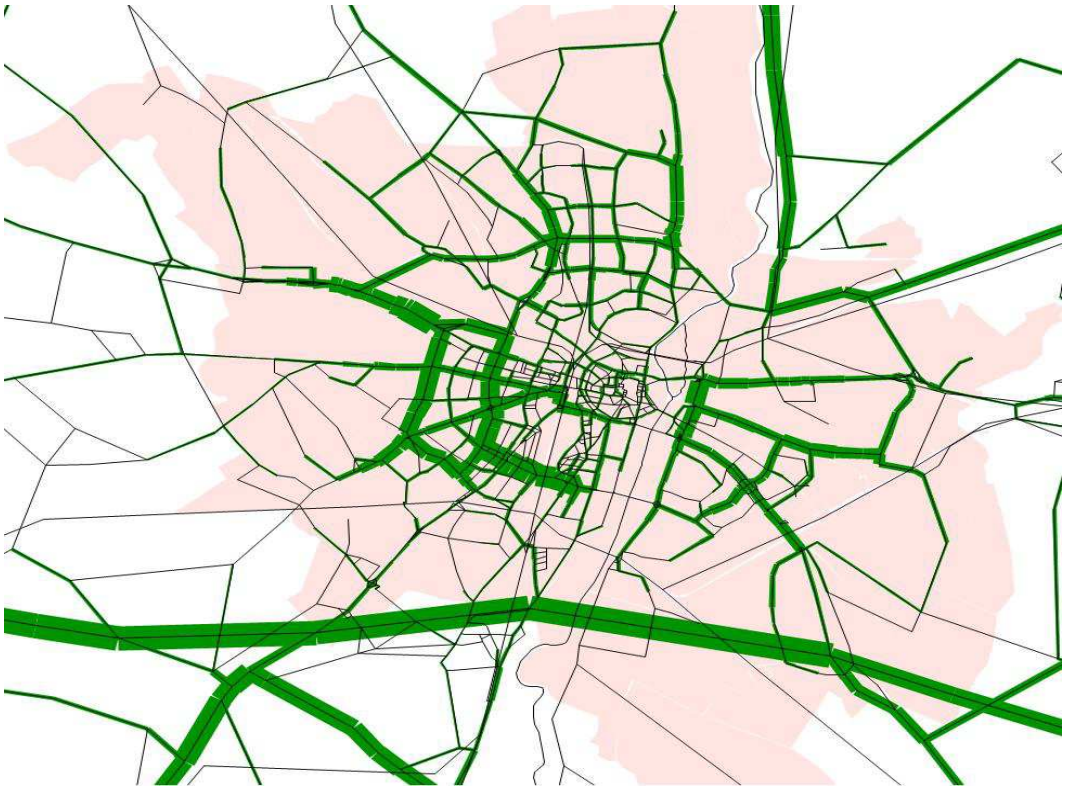
At present, the most occupied parts of the communication system of the city of Poznan are the highway, the south-west and east part of the Communication Frame II, the south-west part of the Communication Frame I, Bukowska and Grunwaldzka streets. These streets are the connections between the west part of the city and Communication Frames I and II (Fig. 1).

The biggest problems in the smooth motion of vehicles mainly concern the streets of the city (Fig. 2) located inside the Communication Frames I and II (the strict centre of the city). Since they have a huge impact on the urban distribution of goods in Poznan, the examples of these obstructions and methods how the city of Poznan tries to overcome the current communication problems are described in this paper.



Source: Administration of the City of Poznan

Fig. 1. Proposed target communication framework of Poznan
Rys. 1. Propozycja docelowego układu ram komunikacyjnych Poznania



Source: Administration of the City of Poznan

Fig. 2. The load of road network by the delivery transport
Rys. 2. Obciążenie sieci drogowej ruchem transportu ciężarowego i dostawczego

The fulfillment of the transport needs of the city is one of the most difficult problems. The reason of such a situation is the lack of the consistency between the spatial structure of the city and the transport systems existing and functioning inside this city. The logistics can be very helpful in this situation by the implementation of the suggestions for new localizations of those elements of logistic infrastructure of the city, which influence mostly the inadequacy of above-mentioned structures [Szoltysek, 2007].

The modern city logistics introduces the reduction of the transport motion inside the strict city centre by the use of integrated systems of the transport management. It forces to look for new solutions for the use of the means of transport, which are included in such a system of the transport management in the cities [Lewandowski, 2002].

Currently the most burdensome elements of the process of the distribution of goods in Poznan are loading and unloading operations carried out mainly for small shops, which are located in the centre of the city. It is connected with the specific character of the narrow streets in the historic part of the city and the lack of unloading bays arranged along the main streets having the high traffic load. The carried out loading and unloading operations contribute to the difficulties of both pedestrian and vehicles traffic.

The main transportation problems of Poznan are:

- excessive traffic in relation to the capacity of the road infrastructure, causing the blocking of the transportation system,
- transit freight transport inside the city,
- big amount of transports associated with deliveries to residents and companies located within the city,
- lack of parking places in the centre of the city,
- high emission of fumes generated by the means of transport,
- high level of noise caused by means of transport,
- devastation of city roads by means of transport.

In order to solve these problems, the city authorities introduced a limited-entry zone for lorries, except for delivery cars carrying the supplies to the clients located in the centre of the city. Additionally, the special so called time-windows were been set on some streets during which the delivery trucks can park and unload the goods. However, the introduced limitations did not solve completely the still existing problem, due to the fact, that drivers commonly break the traffic regulations. Furthermore, there is an additional problem with the enforcement of existing traffic rules and consequently the cars, left on the roadway, block the traffic of vehicles and the trams as well as the cars, parking on pavement, block the pedestrian traffic. Moreover, it can be observed quite often how the providers, carrying the boxes of goods, go among the parked vehicles.

One of the reasons of the existing situation is the fact that, several suppliers, which are not coordinated in any way, realize the deliveries to a single shop. Therefore, the location of the shops belonging only to stores chains in the centre of the city would be the better solution, because such chains usually have their own distribution network, based on consolidation centres located in the outskirts of the city. Deliveries are carried out in a coordinated way taking into consideration the minimization of transportation costs and thus the minimizing the quantity of vehicles on roads.

The city logistics is a way of thinking, operating in the field of competing requirements against limited resources of the urban area. Taking into account this assumption, it is necessary to extract the transport problems in a limited urban space. It leads to the considerations related to issues of the optimization of the flow of means of the transport in the existing communication infrastructure of the city. This task demands careful studies on reasons of the congestion in the city area as a whole and also in separated parts of the city. The important feature of the centre of the city is the congestion created due to the no-optimized system of streets and a big street traffic, both having a journey target

in the centre of the city and a transit one. This causes significant problems in the process of the supplying the customers located both in the centre of city as well as in its outskirts. This problem requires the relocation of the transit traffic out of the centre of the city.

Therefore, in order to reduce the delivery traffic in the centre of the city of Poznan, it is purposeful to create a consolidation centre for the city, from which the goods could be delivered by the use of e.g. the freight trams. The goods from different suppliers could be stored in such a city consolidation centre. At present, such solutions are used successfully in some European cities, e.g. in Dresden. The biggest disadvantages of such solutions are the high investment costs associated with the construction of the needed infrastructure, while the advantages are low operating costs and the reduction of the traffic of big trucks in the city centre.

Another problem faced by the local authorities is the lack of the logistic centre, where the goods for the agglomeration of Poznan could be stored. The existing large warehouse centres around Poznan are built only by private investments and therefore the local authorities have no big influence on the coordination of the flows of the goods within them.

The advantage of the coordination of the flows of goods, being handled by the use of the logistics centres as the nodal points, is the possibility to transfer a significant part of their volume by the use of the alternative means of the transport, such as the combined transport. In the case of the city of Poznan, there is a great potential in the area of the railway infrastructure. The transfer of the transport of goods conducted now by the use of the road transport to the railway transport could reduce significantly the quantity of cars entering the centre of the city.

The use of packing automates in the distribution process is another method to reduce a quantity of delivery cars in the centre of the city. At present, one of the courier company operated in Poznan, offers such a service, where the shipments are delivered by the individual clients to these packing automates, from which they are taken once a day. This way of organizing the collection of courier shipments eliminates the unnecessary entrances of courier cars to the centre of the city, parking in the illegal places and therefore blocking the road and the pedestrian traffic.

This short description of the complications associated with the distribution of goods in urban areas shows, that occurring problems are not easy not only to be solved but also to be identified and parameterized. The local plans of activities in this area should be based on real and detailed date concerning the transport of goods in the city area. At present, the local authorities do not possess such data.

DIRECTIONS FOR THE IMPROVEMENT OF TRANSPORT SERVICES OF POZNAN IN TERMS OF SUGAR PROJECT

In Europe, the professionals focus their attention on the city logistics, recognizing its huge influence on the management of the entire traffic in the cities. Realizing how important the city logistics is, Regione Emilia Romana and Fondazione Istituto sui Traspoti e la Logistica (ITL) already in 2007 year started to work on SUGAR project (Sustainable Urban Goods logistics Achieved by Regional and local policies). In 2009, the SUGAR project was successfully incorporated into the subsidized EU project INTERREG 4C, which is scheduled to the end of February 2012.

The main objective of the SUGAR project is to analyze the causes of the inefficient and ineffective management of freight transport in the city, which still affects the city distribution of goods in most European cities. SUGAR project promotes the exchange, the discussion and the transfer of experiences and good practices among the Cities of Good Practice (Bologna, London, Paris, Barcelona) and the Transfer Cities (Poznan, Palma de Mallorca, Crete, Athens, Vratsa, Celje, Usti at Laba), by providing the update of policies and the development of planning of the management of the city transport of goods. Therefore, the identification of good practices within the project SUGAR plays a key role in supporting the planning of the regional policies. The exchange of the knowledge connected with the good practices, acts as a lever to stimulate the development of local activities plans concerning the city logistics.

One of the main objectives of SUGAR project is to initiate and facilitate the development of such plans. It is also the reason, that the creators of these policies are the first beneficiaries as well as the target group of SUGAR project.

Poznan plays a transfer part in the SUGAR project that means it takes over the knowledge of good practices in the management of the transport of goods in the cities, which is already used successfully for years in other agglomerations of European Union and outside it. The task of Poznan city is to develop the action plan aimed at reducing the negative effects of the delivery traffic in the city.

In accordance with the Transport Policy of the City of Poznan, adopted by the City Council still in 1999, the city authorities should decide for the solutions, which reduce the difficulties for inhabitants caused by the transport and improve its efficiency, and thereby aiming to achieve a sustainable transport system in economic, spatial, ecological and social terms. The transportation of goods is one of the elements of the Transport Policy, which sets some goals and directions of the development, such as the release of the residential areas from the traffic caused by the transport of the goods.

Therefore, by the participation in the SUGAR project, the city of Poznan plans to develop the action plan for improving the efficiency of the transport of goods in the city. This plan will be submitted for the approval by the City Council and will be the fifth consecutive program, which details the points of the Transport Policy. The four previous ones are:

- Sustainable Development Program for Public Transport,
- Road Program,
- Parking Policy,
- Bicycle Program.

COCNLUSIONS

The expectations of the rationality of the analyzed solutions (also in the aspect of the sustainable development of the city) will be met only under condition that there will be a linear access (by road) to this area of the city, which is particularly exposed to the intensity of the transport activities. In addition, the efficient use of ring roads and the communication framework should lead to the time savings comparing to the use of traditional presently available network of streets. The communication rings should be connected by short radial sections of city roads, which will form the nodes allowing the efficient access to the centre of the city.

The SUGAR project is the first project of the exchange of the experiences in the area of the transport of goods, in which the Office of City of Poznan participates as a partner (this office manages the logistics of the city). The cooperation within this project should help to find effective solutions to existing transport problems of the city. This is particularly important from the perspective of the challenges, which the city agglomeration of Poznan will face, including the organization of EURO 2012.

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RACJONALIZACJA PROCESÓW TRANSPORTOWYCH W LOGISTYCE MIEJSKIEJ

STRESZCZENIE. Artykuł obejmuje treściowo problematykę racjonalizacji przepływów osób i towarów w obszarach aglomeracji miejskich. W warunkach wzrastającej kongestii ruchu drogowego stanowi to jeden z ważniejszych problemów efektywnego zarządzania miastami, zgodnego zwłaszcza z zasadami zrównoważonego rozwoju. W poszczególnych częściach artykułu przedstawiono lokalne uwarunkowania logistyczne dla aglomeracji miejskiej Poznania, ze szczególnym uwzględnieniem utrudnień związanych z miejską dystrybucją towarów. Ponadto wskazano na możliwe źródła pozyskania dobrych praktyk dla władz lokalnych, jakimi są m.in. projekty europejskie, np. projekt SUGAR. (Sustainable Urban Goods logistics Achieved by Regional and local policies).

Słowa kluczowe: zarządzanie miastem, logistyka miejska, rozwój zrównoważony, miejska dystrybucja towarów, przepływy osób i ładunków, infrastruktura drogowa miast, projekt SUGAR.

OPTIMIERUNG VON TRANSPORTPROZESSEN IN DER STÄDTISCHEN LOGISTIK

ZUSAMMENFASSUNG. Das Problem der Rationalisierung des Flusses von Menschen und Gütern in städtischen Gebieten ist in den vorgestellten Artikeln diskutiert. In den Bedingungen von der steigenden Verkehrsstockung ist das eines der wichtigen Probleme der effektiven Stadtverwaltung, die im Einklang mit den Grundsätzen der guten Praxis ist. Der Artikel präsentiert die heimischen logistischen Anforderungen für die städtische Agglomeration von Posen, mit besonderem Augenmerk auf Schwierigkeiten der Verteilung von Gütern in städtischen Gebieten. Zusätzlich, die mögliche Quelle des Gewinn von guten Praxis wurden vorgestellt, z.B. Europäischen Projekten wie SUGAR Projekt.

Codewörter: Stadtverwaltung, städtische Logistik, nachhaltige Entwicklung, Verteilung von Gütern in städtischen Gebieten, Flusse von Menschen und Gütern, die Straßeninfrastruktur in den Städten, SUGAR Projekt.

Zbyszko Pawlak
Wyższa Szkoła Logistyki
ul. Estkowskiego 6
61-755 Poznań, Polska
e-mail: zbyszko.pawlak@wsl.com.pl
Maciej Stajniak
Wyższa Szkoła Logistyki
ul. Estkowskiego 6
61-755 Poznań, Polska
e-mail: maciej.stajniak@wsl.com.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 1
No 3

http://www.logforum.net

MODELLING OF VIRTUAL PRODUCTION NETWORKS

Sebastian Saniuk

University of Zielona Gora, Zielona Góra, Poland

ABSTRACT. Nowadays many companies, especially small and medium-sized enterprises (SMEs), specialize in a limited field of production. It requires forming virtual production networks of cooperating enterprises to manufacture better, faster and cheaper. Apart from that, some production orders cannot be realized, because there is not a company of sufficient production potential. In this case the virtual production networks of cooperating companies can realize these production orders. These networks have larger production capacity and many different resources. Therefore it can realize many more production orders together than each of them separately. Such organization allows for executing high quality product. The maintenance costs of production capacity and used resources are not so high.
In this paper a methodology of rapid prototyping of virtual production networks is proposed. It allows to execute production orders on time considered existing logistic constraints.

Key words: virtual organization, production network, production flow planning.

INTRODUCTION

A high degree of enterprises specialization in limited field of production and much more potential of advanced computer and telecommunication systems like global networking or groupware systems [Tuma 1998, Huang et al. 2008] cause development of cooperation between enterprises carrying out common production orders in virtual production networks. The most popular of them called "virtual enterprises" or "virtual organizations".

The conception of virtual enterprises is characterized by a distinct form of network organization in combination with a high degree of organizational flexibility [Tuma 1998]. An idea of manufacturing in a network means joint manufacturing, while enterprises offer essential production capacity to manufacture products according to production orders. This solution allows for executing production orders by a group of specialized enterprises, whereas one of them could not have realized a given production order because of lack of production potential [Verwijmeren 2004].

A Virtual Organization (VO) can be seen as a temporary or permanent coalition of geographically dispersed organizations that pool resources in order to achieve common goals [Arenas, Aziz et al. 2008]. It is necessary that the potential partners are ready and prepared to participate in collaboration. The potential for development gives the current exploitation of Internet technology to create virtual enterprises [Arenas, Aziz et al. 2008, Corvello and Migliarese 2007].

Citation: Saniuk S., 2011,, Modelling of virtual production networks. LogForum 7, 1, 3
URL: http://www.logforum.net/vol7/issue1/no3
Accepted: 14.01.2011, on-line: 02.02.2011.

Virtual organizations differ from other traditional enterprises in the following features: dynamics of network reconfiguration with flexibility, agility, operational dimension, competitiveness, resource optimization and innovation. VO can form integration as well as reconfiguration dynamics [Putnik et al. 2005, Camarinha-Matos and Afsarmanesh 2007].

There are different forms of virtual organizations. A well-known form is the temporary cooperation of dedicated enterprises in order to integrate their skills in a certain project and to reduce their individual risk (cooperating form). An example of this solution is a banking syndicate or a consortium of oil companies. A more advanced form is the establishment of a new cooperative enterprise as a network of independent, substitutable companies (cooperative form). This is a kind of a temporary, project-dependent portfolio of core competencies [Tuma 1998, Vidová 2006].

Last time database systems in the Internet have been formed, which gather information about production capacity in SMEs. These systems help to find partner to cooperate. Unfortunately, businessmen are not interested in these solutions. The main reason for that is lack of data-introducing rules and aversion to delivering confidential information about enterprise such as production costs, etc. to such an easy accessible system like Internet. Therefore, it is necessary to work out a method of quick prototyping of virtual production networks in SMEs, which are able to make a new production order on time, according to production capacity and given transportation system of the set of enterprises.

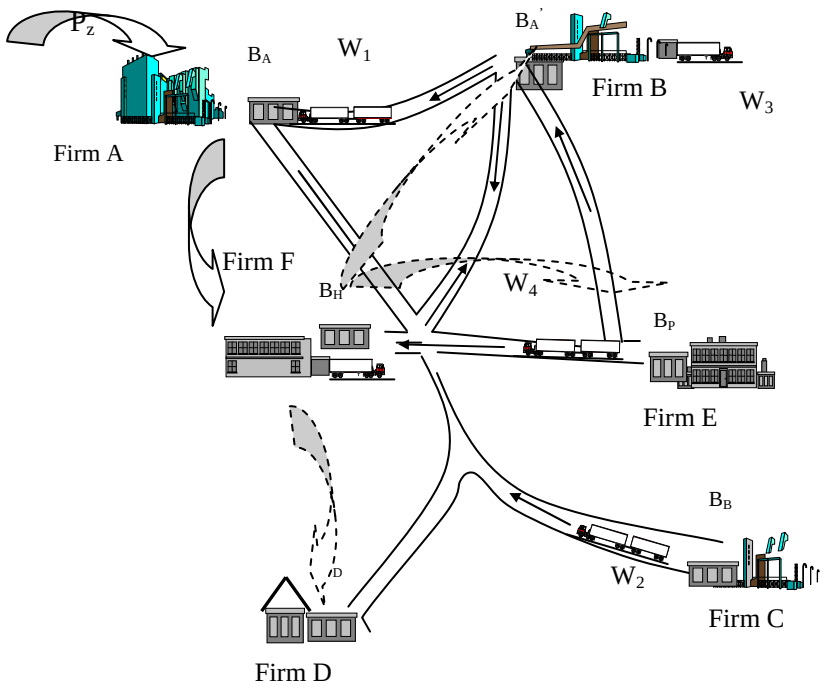
It is not easy to set acceptable variants of virtual production networks because it is a problem of a large complexity. The known and applied methods (like optimization and simulation methods) are very time-consuming, work-consuming and therefore expensive [Zhuge, Chen, Feng, Shi 2002]. It is not possible to set acceptable solutions in on-line mode to use them. Therefore, one should do research; implement methods and computer systems which can set quickly acceptable variants of planned production order execution with consideration to resources and financial and logistic limitations.

In this paper, a new methodology of virtual production networks prototyping is suggested. It allows to execute production order on time, according to logistic constraints. When is given a set of enterprises with known production capacity and there is a production order specified in terms of quality and delivery time, a virtual production network is formed. This paper suggests to use a broker. The broker is an independent enterprise, which collects needed information about co-operators. The broker is not competitive neither as production enterprise nor transportation enterprise. It allows for secure keeping of the transferred information.

MODEL OF PRODUCTION NETWORK

There is a set of SMEs manufacturing in specialized and limited field of production. These enterprises have certain production capacity. Given limitations are the following: production capacity (a kind of operations, time of availability, cost of using production resources), transportation routes, means of transport (quantity, capacity, time and cost of drive) and capacity of storehouses.

The very important component of the presented model is a transaction broker. The main target activity of this broker is connecting cooperating companies, which would be able to execute production order with known limitations. The broker organizes a set of enterprises that guarantees that production order execution is on time and with low production costs. The scheme of the presented model is illustrated on Fig.1.



Legend:
Firms A, B, C, D, E, F – enterprises which are able to execute production order P_z;
$W_1, \ldots, W_4$ – means of transport;
- process material flow P_1;
- alternative process material flow P_1.

Source: own work

Fig. 1. The model of virtual production network
Rys. 1. Model wirtualnej sieci produkcyjnej

There is a planned production undertaking (production order), execution of which exceeds potential of single enterprise, according to its production capacity and possessed technology. The production order is specified by size of planned production, given time of execution and costs of realization (price). The way of production order realization is described by production process Pz = (O_1, O_2, …, O_i), marked as a vector. The elements of this vector are characterized by partial operations which are executed in individual enterprises.

In common case the following research problem is considered: is there a network of enterprises which can execute production undertaking on time and according to logistic constraints?

The solution of this problem requires answering the following questions:

- Does structure of production capacity in time of cooperating enterprises allow for execution of a new production order?
- Can a new production order be executed using existing transportation system?
- What is total cost of production order execution?

In considered case there is assumed the following hypothesis: There is an effective computational methodology of virtual networks variants prototyping for enterprises from SMEs which have production capability in conditions of deterministic resources and logistic constraints of the system.

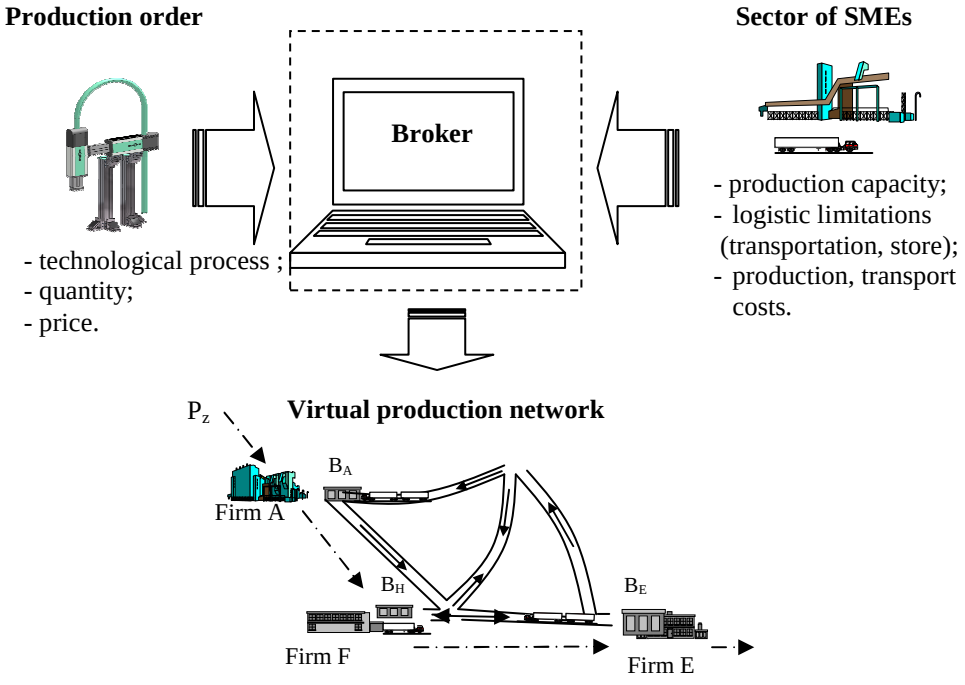
The main goal of research is to propose a methodology of rapid prototyping of a virtual production network. The following partial goals have to realize to fulfill the main goal:

- to work out a model of virtual production network of SMEs;
- to work out a set of sufficient conditions, fulfillment of which guarantee production order execution in a network on account of resources and logistic constraints;
- to work out a proposal of an algorithm based on checking of sufficient conditions sequence.

RAPID PROTOTYPING OF VIRTUAL PRODUCTION NETWORKS

The prototyping of virtual production organizations (networks) based on selection such enterprises which have production capacity and allow for production orders execution. The important instrument of suggested conception of prototyping is a production capacity exchange platform which is represented by transaction broker. The broker has to select such enterprises which guarantee execution of production undertaking. The scheme of information flow to be used by broker is shown on Fig. 2.

The suggested solution matches demands of described production undertaking and supplying which means better production possibilities of geographically dispersed enterprises [Saniuk S. and Saniuk A. 2009]. Impermanent organizations which are able to realize common undertaking are to be involved. In practice, enterprises submit an offer of production capacity and give costs of using this capacity in transaction broker system. This kind of information is updated in on-line mode using computer system. The broker raises production orders which demands using many specialist companies. When enterprises are connected in an effective virtual organization, it assures qualitative correct material flow using outside transportation. At the same time there is not execution disruption of other production orders in cooperating enterprises.



Source: own work

Fig. 2. The production capacity exchange platform
Rys. 2. Platforma wymiany zdolności produkcyjnych

The network organizing requires to solve a large-scaled computational complexity problem. Known and used methods especially optimization and simulation methods are very time-consuming, work-consuming and cost-consuming. Using of these methods makes difficult a possibility of acceptable solution finding in on-line mode. Therefore, an algorithm is suggested, based on checking sufficient conditions fulfillment, which guarantees acceptable production order execution [Saniuk S., Saniuk A. 2008]. Checking of sufficient conditions sequence (a set of algebraic-logical conditions) reduces an initial set of solutions (formula 1) on account of resources and logistic constraints. The final solution is a set of variants which fulfillment of discussed constraints. The proposed methodology is shown in Fig. 3.

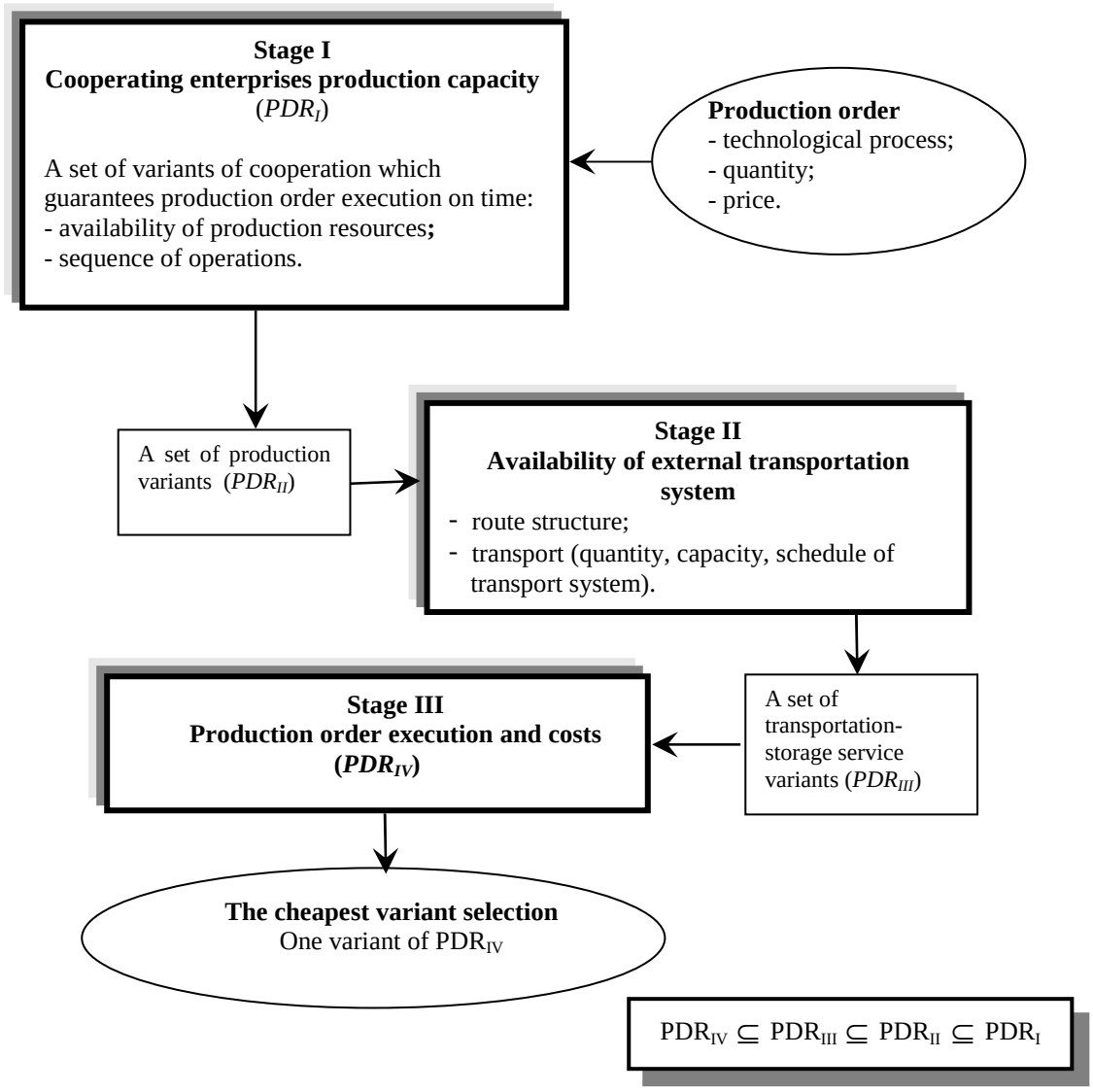


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Fig. 3. The methodology of rapid prototyping in virtual production networks
Rys. 3. Metodyka szybkiego prototypowania wirtualnych sieci produkcyjnych

The presented methodology consists of three stages. In the first stage a set of acceptable variants of network (space of acceptable solutions) PDR_I is formed, which meets the requirements of operation kind. The initial space of potential solutions can be set according to formula 1. Using formula 1 is illustrated in a case study (fourth part of this paper).

$$PDR_I = \prod_{i=1}^{m} e_{p_i} , \quad (1)$$

where:

e_{pi} - quantity of enterprises which are able to execute i-operation according to operation kind (for example assembly);

m - quantity of operations in process.

A set PDR_I is narrowed on the basis of checking next sufficient conditions. In this stage production capacity (machines, workstation, etc.) of each enterprise and sequence of operations are checked. The set is reduced to a set PDR_{II}. It sets time and size of delivery batches.

In the second stage, a set of variants is limited to such variants, which fulfil conditions connected with transportation and storage systems. Each variant is checked according to available route structure, quantity and capacity of transportation means and storehouse capacity of co-operators. In proposed approach transportation system realizes operations of material transferring between enterprises according to the established schedule. Transportation means with known capacity move along given routes of connected participants of logistic network. The schedule is established on the basis of offers of forwarding enterprises which guarantees availability of transportation means with given capacity in a length of time in given section of route. It allows for quick and credible assessment of possibility of transportation operations execution, without time-consuming and cost-consuming planning of transportation timetable.

Appling of the suggested solution guarantees possibility of finding quality acceptable solutions, if such are. As a result of this, there are acceptable variants of network (PDR_{III}) with variants of transportation-storage support which guarantee production order execution on time.

In the third stage of suggested methodology, planned cost of production order execution is calculated. It is determined by a set of PDR_{IV} solutions, which guarantees production order execution on time. The cheapest variant is selected. The costs of production order execution are divided into some groups of costs like: material costs, individual process costs, transportation costs, insurance costs, store costs and costs of broker service.

The individual process costs are determined by cooperating enterprises. Using Activity Based Costing to calculate unit cost of process is proposed. The concept of this method is the basis for assuming that indirect costs arise when enterprise takes activities, which serve to produce products or service and deliver them to customers. Activity Based Costing introduces additional stage of calculation in which activities are priced. The level of indirect costs of each product (process) depends on a kind and quantity of activity, which is needed for execution [Stadtler 2005]. The cost of process calculated in this way is increased by mark-up of co-operators.

In considered approach all variants, which guarantee production order execution on time, are distinguished. The information about costs allow for selection of the cheapest variant of cooperating network.

When a set of solutions runs out, the proposed methodology is assumed to reject planned production order. Information about reasons of rejecting is known. It means that does not exist a set of enterprises, which guarantees a production order execution on time.

EXAMPLE OF RAPID PROTOTYPING OF NETWORKS

There are six independent production enterprises: A, B, C, D, E and F, which entered to the production capacity exchange platform and two means of transport W1, W2. Each production

company can make only some technological operations, what is shown in Table 1. Forming of network variants in Fig.4.

Table 1. Time and costs of operations realization
Tabela 1. Czasy i koszty realizacji operacji produkcyjnych

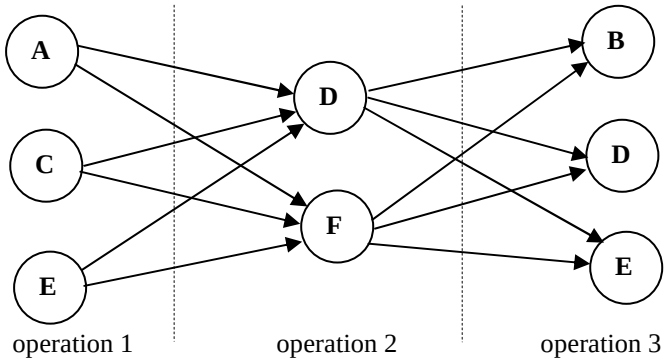
Company/operation	operation 1 (time/cost) per unit	operation 2 (time/cost) per unit	operation 3 (time/cost) per unit
Firm A	10 ut*/2 $	-	-
Firm B	-	-	10 ut/ 7 $
Firm C	15 ut/ 3 $	-	-
Firm D	-	22 ut / 22 $	12 ut / 8 $
Firm E	22 ut / 6 $	-	13 ut / 12 $
Firm F	-	5 ut / 10 $	-

* units of time

Source: own study

The broker gets a new planned production order Z_1 to execute in virtual organization. This production order is characterized by volume of pieces output Q=3 000 and the time limit T_E=5500 units. A customer (employer) determined maximum price of production order execution 95 000 $. The production process of this order consists of three technological operations: operation 1, operation 2 and operation 3.

The presented approach permits to select resources (partners of a virtual organization) that guarantee the completion of production order within a fixed time limit and with relatively low costs considering logistic limitations. Using of proposed methodology allows for six enterprises for selection, which can form a virtual production network. The first operations will be made by enterprise A, C and E. The second one will be made by D and F enterprise and the third can be made by enterprise B or D or E. In Table 1, there is presented time (in units of time) and cost (in $ per piece of product) of each operation execution in every enterprise.

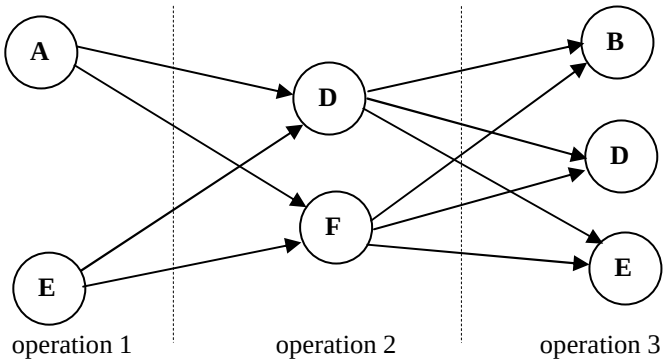


Source: own study

Fig. 4. Forming of network variants
Rys. 4. Wariantowanie sieci

On the basis of the methodology, which is illustrated in Fig. 2, variants of network are formed. Depending on a kind of technological operations, there can be formed 18 variants of network (3x2x3=18) (see formula 1). There is a set PDR_I.

Next, availability of resources in each enterprise in a given time is checked. The first operation cannot be realized in company C. So a set is reduced to 12 variants. Six variants are rejected (C-F-B, C-F-D, C-F-E, C-D-B, C-D-D and C-D-E), what is shown in Fig. 5.

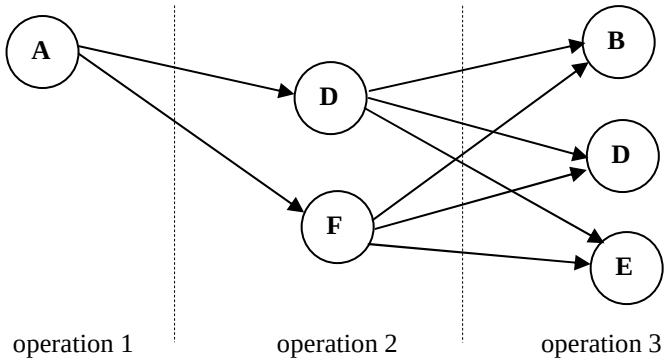


Source: own study

Fig. 5. Forming of network variants
Rys. 5. Wariantowanie sieci

In the second stage, existed variants according to availability of transportation are examined, what is shown in Tab. 2. The cooperating enterprises are operated by forwarding enterprises. Two means of transportation carry components between cooperating firms.

Vehicle capacity and transportation schedule in considered time is known. There are no means of transport in stretches between enterprise E and D (E-D) and E and F (E-F) in a needed time. So a determined set of variants is reduced to 6 variants. Six variants are rejected (E-D-B, E-D-D, E-D-E, E-F-B, E-F-D, E-F-E). It has created a set PDR_{II} (see Fig. 6).



Source: own study

Fig. 6. Forming of network variants
Rys. 6. Wariantowanie sieci

Table 2. Transportation routes and delivery times
Tabela 2. Trasy i czasy operacji transportowych

Track	**Transportation routs (transportation time/ cost)**
W_1	Firm A – Firm F (100ut/500$) Firm F – Firm D (100ut/450$) Firm A – Firm D (200/750$)
W_2	Firm F – Firm B (100ut/480$) Firm F – Firm E (120ut/400$) Firm D – Firm B (130ut/800$) Firm D – Firm E (100 ut/790$)

Source: own study

In the next stage, costs of production order of each variant are calculated. The variants with costs of execution above 95 000 $ are rejected. There are three variants (A-D-B, A-D-D, A-D-E). In these variants the costs of execution amount to 97 550 $, 96 750 $ and 109 540 $ respectively. It has formed a set PDR_{III}.

Finally, three variants of production order Z_1 execution are established. These variants are shown in Tab. 3. The second variant has been accepted to execution, because costs of this variant are the lowest.

Table 3. Characterization of variants
Tabela 3. Charakterystyka dopuszczalnych wariantów

Variants	Companies	Total costs	Execution time
1	A – F – D	60 950 $	81200 ut
2	**A – F – B**	**57980 $**	**75200 ut**
3	A – F – E	72900 $	84220 ut

Source: own study

CONCLUSIONS

The possibility of using production potential of cooperating enterprises allows for development of small and medium-sized enterprises (SMEs). It means that SMEs organized as virtual production network can compete with much bigger enterprises of much higher capital. These solutions allow for better usage of production potential, increase of SMEs production system productivity outcome and reduce costs.

The most important problem of forming virtual production network is lack of methods and computer systems, which would allow for quick and credible specifying of new possibility of production undertaking realization. Therefore, there is a need to form an exchange production capacity platform using a methodology of quick prototyping of acceptable production network organization and production workflow, which guarantees accurate execution of production orders.

In this paper, a methodology based on propagation of constraints of cooperating enterprises is suggested. The main goal of this methodology is to select co-operators that are able to execute production processes in a network and, assuming possibility of planned production order, to realize them in conditions of transportation systems and storage constraints.

The further research concentrates on describing technological operations and logistic operations (transport, storage) of potential co-operators and also on working out of computer exchange production capacity platform. This platform will allow for quick prototyping of virtual production network, which will be flexible and economically effective.

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MODELOWANIE WIRTUALNYCH SIECI PRODUKCYJNYCH

STRESZCZENIE. Obecnie wiele przedsiębiorstw, szczególnie z sektora MŚP, specjalizuje się w bardzo wąskim zakresie produkcji. Żeby produkować lepiej, szybciej i taniej, wymagane jest tworzenie wirtualnych sieci produkcyjnych kooperujących przedsiębiorstw. Ponadto, niektóre zlecenia produkcyjne nie mogą być zrealizowane, ponieważ nie istnieje przedsiębiorstwo o dostatecznym potencjale produkcyjnym. W tym przypadku zlecenia tego typu mogą zostać zrealizowane w produkcyjnych sieciach kooperujących przedsiębiorstw. Większe zdolności produkcyjne i różnorodność zasobów kooperujących sieci przedsiębiorstw pozwala zatem wspólnie zrealizować dużo więcej zleceń niż każde z nich z osobna. Taka organizacja umożliwia wykonywanie wysokiej jakości produktów przy niskich kosztach utrzymania i wykorzystania zdolności produkcyjnych.
W artykule zaproponowano metodologię szybkiego prototypowania wirtualnych sieci produkcyjnych, które pozwalają na terminową realizację zleceń produkcyjnych uwzględniając istniejące ograniczenia logistyczne.

Słowa kluczowe: wirtualna organizacja, sieci produkcyjne, planowanie przepływu produkcji.

MODELLIERUNG DER VIRTUELLEN PRODUKTIONSNETZWERKE

ZUSAMMENFASSUNG. In der heutigen Zeit spezialisieren sich viele Unternehmen (besonders kleine und mittlergroße Unternehmen) in einem begrenzten Bereich der Produktion. Es fordert die Bildung der virtuellen Produktionsnetze von kooperierenden Unternehmen um besser, schneller und billiger zu produzieren. Abgesehen davon, können einige Fertigungsaufträge nicht realisiert werden, weil es keinen Unternehmen mit der genügenden Produktionskapazität gibt. In diesem Fall können die virtuellen Produktionsnetze von kooperierenden Unternehmen diese Fertigungsaufträge realisieren. Diese Netze haben größeren Produktionskapazitäten und viele verschiedenen Ressourcen. Deshalb können sie mehr Fertigungsaufträge realisieren als nur einer von ihnen. Solche Organisation ermöglicht hochwertigen Produkten zu herstellen. Die Unterhaltungskosten der Produktionskapazität und verwendeten Ressourcen sind nicht so hoch.
Eine Methode des "Rapid Prototyping" von virtuellen Produktionsnetzen wird in diesem Artikeln vorgeschlagen. Sie erlaubt die Produktionsaufträge termingerecht in angegebenen logistischen Begrenzungen.

Codewörter: virtuelle Organisation, Produktionsnetz, Flussplanung der Produktion.

Sebastian Saniuk, PhD
Institute of Computer Science and Production Management
University of Zielona Gora
4 Szafrana Street
65-516 Zielona Gora
e-mail: s.saniuk@iizp.uz.zgora.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 1
No 4

http://www.logforum.net

PACKAGING SYSTEMS FOR ANIMAL ORIGIN FOOD

Agnieszka Bilska

Poznań University of Life Sciences, Poznan, Poland

ABSTRACT. The main task of food packaging is to protect the product during storage and transport against the action of biological, chemical and mechanical factors. The paper presents packaging systems for food of animal origin. Vacuum and modified atmosphere packagings were characterised together with novel types of packagings, referred to as intelligent packaging and active packaging.
The aim of this paper was to present all advantages and disadvantages of packaging used for meat products. Such list enables to choose the optimal type of packaging for given assortment of food and specific conditions of the transport and storing.

Key words: vacuum packaging, modified atmosphere packaging, smart packaging, intelligent packaging.

INTRODUCTION

Packaging of foodstuffs is one of the primary procedures which prevent the penetration of microbiological and biochemical contamination to the product. It facilitates transport and distribution of the final product (particularly in supermarkets) and the maintenance of an appropriate form of the product, its shape and structure [Appendini and Hotchkiss 2002, Olborska and Lewicki 2005, Świątkowska et al. 2006, Rak 2007, Korzeniowski 2010, Zhou et al. 2010]. It also prevents the loss of aroma, extends shelf life and maintains adequate moisture content [Olborska and Lewicki 2005, Świątkowska et al. 2006, Rak 2007, Zhou et al. 2010].

Production of food safe for the consumer, being of high quality and the longest possible shelf life, are tasks faced by food producers. An essential role in this process is played by packagings as well as packaging methods: vacuum packaging and modified atmosphere packaging (MAP).

Since mid-1990's interest of researchers has focused on new types of packagings, defined as intelligent packaging and active packaging.

The aim of this study was to indicate methods of packaging for food of animal origin, which would be optimal for selected assortments and different buyers, taking into consideration transport conditions and the assumed shelf life of the product.

MATERIALS USED IN PACKAGING PRODUCTION

When selecting packaging material we need to know the characteristics of the final product, e.g. its chemical composition, consistency and texture. It is also necessary to consider whether the packaged

Citation: Bilska A., 2011, Packaging systems for animal origin food. LogForum 7, 1, 4
URL: http://www.logforum.net/vol7/issue1/no4
Accepted: 24.01.2011, on-line: 12.02.2011.

product can stand storage, distribution and sale conditions until it is delivered to the consumer [Korzeniowski and Kubera 2000, Jeremiah 2001].

At present almost entirely composite, multi-layer materials are used. In composite plastic films some of the following materials and their derivatives are used: polyethylene (PE), polyester (PET), polyamide (PA, particularly polyamide PA6), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyvinylidene dichloride (PVDC), ethylene-vinyl alcohol (EVOH), copolymers with an addition of acrylic acid, vinyl acetate, etc.

The outer layer of multi-layer plastic film packaging is assigned mainly tasks connected with mechanical stability, the core layer plays the role of a barrier for oxygen, while the inner layer provides bursting strength and rupture strength of the weld and the packaging [Czerniawski and Michniewicz 1998, Korzeniowski and Kubera 2000, Michniewicz 2000, Jeremiah 2001].

Materials used in the production of packagings should meet many requirements. First of all they need to be non-toxic, chemically inert (product - environment) as well as transparent and smooth. They should exhibit an adequate permeability for gases and water vapour, and be water-resistant [Jeremiah 2001, Gajewska - Szczerbal 2004].

VACUUM PACKAGING

Vacuum packaging consists in the removal of air from the packaging, which is next sealed tightly, usually by welding. The presence of oxygen in the packaging results in many adverse changes, e.g.: autoxidation of fats (rancidity), changes of taste and aroma, oxidation of pigments, vitamin C, vitamin E, beta-carotene and certain amino acids, as well as the development of aerobic microflora, particularly moulds. For this reason by removing oxygen from the medium we may inhibit the development of aerobic bacteria as well as yeasts and moulds, which cause food spoilage [Danyluk et al. 2004, Gajewska - Szczerbal 2005, Kerry et al. 2006, Czerwńska 2006, Zhou et al. 2010]. This system is applied e.g. in packaging of meat and meat products, cheeses and dairy produce [Kačeňák et al. 2005].

For many consumers the decisive factor in the purchase of fresh meat is its colour. The natural, red colour of raw meat is caused by the presence of myoglobin. In order to preserve an appropriate colour, the used packaging should be characterised by high or the lowest possible oxygen permeability [Issanchou 1996, Jeremiah 2001, Kačeňák et al. 2005, Troy and Kerry 2010]. High oxygen permeability (oxymyoglobin is formed) is found in polyethylene and cellulose acetate. Meat packaged in this manner retains its colour for 1 - 2 days [Kačeňák et al. 2005, Gajewska - Szczerbal 2005a]. When meat is packaged in a packaging with very low oxygen permeability (composite materials), the process of metmyoglobin is inhibited. Thus in meat industry the materials used in vacuum packaging of meat include typically three-layer plastic films containing e.g. vinyl ethyl acetate/vinylidene polychloride/vinyl ethyl acetate, which usually have lower oxygen permeability [Jenkins and Harrington 1991, Zhou et al. 2010].

Vacuum packaging is most frequently used in storage and distribution of cooled parts and culinary elements of beef. It is a particularly common method in the USA, used mainly for large meat elements. This packaging method practically replaced wholesale of whole carcasses.

At vacuum packaging in the corners, the so-called dead spaces are formed, in which drip mat accumulate, which looks unappetizing and deteriorates the appearance of packaged meat. This may be avoided when in packaging a plastic film is used, which sticks to the meat surface very closely and leaves very little space for the accumulation of drip [Jeremiah 2001, Gajewska - Szczerbal 2005a]. Presently used packagings include vacuum sealing bags and shrink wraps. After the removal of air, the product has to be completely covered with plastic film, which should be impossible to detach. Oxygen content in the vacuum packaged product may not exceed 2% [Michniewicz 2000, Jeremiah 2001, Gajewska - Szczerbal 2005a].

Vacuum packaging may be applied only for meat with good microbiological quality. Another very important index, which needs to be carefully watched, is the pH value. Meat with pH 6.0 or higher should not be vacuum packaged. High microbial contamination and high pH values may result in a considerable shortening of meat shelf life [Jeremiah 2001, Gajewska - Szczerbal 2005a].

Another factor limiting shelf life of meat is the temperature of its storage. The best effects may be obtained during meat storage at a temperature close to cryoscopic. Vacuum packaged beef may be stored at 0^oC for 14 - 28 days. Shelf life of beef with pH over 6.0 is considerably shorter at the same temperature [Jeremiah 2001].

The more comminuted a product is, the shorter its shelf life during cold storage. Vacuum packaged ground meat will keep for a much shorter time than meat in large pieces [McDonald 2000, Czerwińska 2006]. Studies on the stability of raw meats, conducted at a temperature of 2 - 4^oC by Polak et al. [2005] showed that vacuum packaged beef and veal may be stored for 10 days, while deboned turkey cuts - up to 14 days.

Processed finely and medium-comminuted meats (wieners, luncheon meat), in comparison to e.g. ham, have a shorter shelf life [Jeremiah 2001, Czerwińska 2006].

Stability of vacuum packaged products depends also on physico-chemical properties of the product, primarily:

- Water activity, e.g. beef-pork hamburgers at $a_w = 0.985$, stability for 7 days, while at a_w of 0.953 it is up to 28 days,
- Applied heat processing, e.g. cooked foreshank - stability under cold storage conditions up to 14 days, while roast foreshank - stability up to 28 days [Polak et al. 2005].

MODIFIED ATMOSPHERE PACKAGING

Modified atmosphere packaging consists in the replacement of air in the packaging with a mixture of gases with a composition specially selected, depending on the type of the packaged product. The primary gases used in the MAP system include carbon dioxide, nitrogen and oxygen. Carbon dioxide is a gas readily soluble in water and in fats. It is used as a protective gas typically at a concentration of 20 - 30%. It is neutral in terms of taste and aroma. It exhibits bacteriostatic and fungistatic properties [Czerniawski 1999, 2001, Kotsianis et al. 2002, Anonymous 2005, Gajewska-Szczerbal 2005b, Grzesińska 2005, Polak et al. 2005, McMillin 2008, Koutsoumanis et al. 2008]. Nitrogen in the MAP system serves the role of a filling gas. It protects the packaging against "caving in". It results from its poor solubility in water and fats. It does not have a direct effect on the stability of the packaged product. The application of nitrogen before the packaging is filled with other gases aims at the removal of remaining oxygen, undesirable in the packaging. It also delays rancidity processes and prevents the development of aerobic bacteria [Czerniawski 2001, Kotsianis et al. 2002, Gajewska-Szczerbal 2005b, Bilska et al. 2004, Polak et al. 2005, Grzesińska 2005, Zhou et al. 2010]. Oxygen is used in packaging of raw meat. Its addition is used to maintain the characteristic red colour, i.e. oxymyoglobin [Jeremiah 2001, Gajewska-Szczerbal 2005b, Zhou et al. 2010].

Carbon oxide (CO) is a component of modified atmosphere used in packaging of meat and fish. Carbon oxide binds with haeme in hemoglobin or myoglobin and forms a stabile light-red coloured protein complex [Stenzel and Feldhusen 2004]. This leads to the stabilization of meat colour (particularly on its surface) and an extension of its shelf life. However, it may also mask symptoms of meat spoilage and constitute a threat for consumer health. Meat may be exposed to the action of CO before packaging or carbon oxide may be used to remove gas from VSP plastic film before sealing. Small amounts of carbon oxide are enough to provide the desirable red colour of meat [Belcher 2006; Eilert 2005, Sebranek et al. 2006, Zhou et al. 2010]. However, the use of carbon oxide as an additive in meat and fish processing is illegal in view of food law regulations.

One of the advantages of modified atmosphere packaging of raw meat is very small drip of meat juice. However, in packagings containing fresh meat oxygen should be present at an amount sufficient

to provide partial pressure of at least 0.4 hPa (40 millibar) [Jeremiah 2001, Gajewska-Szczerbal 2005b]. Storage of fresh meat in modified atmosphere leads to the dominance of lactic acid bacteria and/or thermosphacta B. [Koutsoumanis et al. 2008].

The selection of the composition of a gas mixture (table 1) should be adapted to a specific type of meat and the type of processed meats, taking into consideration expected temperature conditions during storage and distribution [Zin et al. 2004].

Table 1. The composition of a mixture of gases in modified atmosphere packaging of meat products [Czerniawski 1999, Polak et al. 2005]
Tabela 1. Skład mieszanek gazów w opakowaniach produktów mięsnych o zmodyfikowanej atmosferze [Czerniawski 1999, Polak et al. 2005]

Type of product	Composition of gas mixture [%]		
	O_2	CO_2	N_2
Raw meat	60-85	40-15	-
Fresh beef or pork	70	20	10
fresh meat and sausage made from raw meat	80	20	-
Cooked ham (incl. sliced)		40	60
Smoked sausage	-	30	70
Sausage for grilling	-	25-30	75-70
Meat-filled dumplings	-	30	70
Cooked meat	-	25-30	75-70

When packaging products in modified atmosphere we need to consider not only the composition of gases, but also the packaging material. It should exhibit high impermeability in relation to gases [Czerniawski 2001, Grzesińska 2005].

ACTIVE AND INTELLIGENT PACKAGING SYSTEMS

Production of high quality food with an extended shelf life, which is safe for consumer health is a task faced by producers. Advanced packaging systems have been developed in order to protect the product and extend its stability. These technologies are known as active packaging and intelligent packaging [Zmarlicki 2000, Kačeňák et al. 2005]. Active packaging consists in the spontaneous change in conditions surrounding packaged foodstuffs. Such an action results in an extension of shelf life, improved safety and sensory attributes at the maintenance of product quality [Zmarlicki 2000, Korzeniowski and Czaja 2004, Kačeňák et al. 2005, Dainelli et al. 2008, Zhou et al. 2010]. Intelligent packaging makes it possible to monitor specific parameters in the medium of the packaged product. It informs the consumer on the condition of the product during transport and storage, with no need to open the packaging [Czajkowska 2005, Kačeňák et al. 2005, Kerry et al. 2006, Otles and Yalcin 2008, Dainelli et al. 2008, Kozak and Cierpiszewski 2010].

Active packaging was developed to meet high requirements of consumers, connected among other things with an extension of shelf life of products, improvement of its organoleptic attributes and protection. In order to be able to satisfy these requirements active packagings contain several specific additives. These include oxygen absorbers, substances producing or absorbing CO_2 or sulfur dioxide, antimicrobial substances, ethylene absorbers, moisture content regulators, packagings releasing antioxidants, packagings releasing or absorbing taste and aroma compounds, plastic films protecting product colour and suspectors [Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Korzeniowski and Czaja 2004, Czajkowska 2005, Trzcińska 2006, Kerry et al. 2006]. Examples of applications for different absorbers and applied compounds are given in table 2.

Table 2. Absorbers, their applications and used compounds
Tabela 2. Substancje absorbujące, ich zastosowanie i stosowane składniki

Type of absorber	compounds	applications
Oxygen absorbers	Iron compounds, ascorbic acid, metal salts, glucose oxidases	cheese, bakery products, sweets, nuts, milk powder, coffee, tea, beans, cereals, meat
Moisture absorbers	Silica gel, glycerol	Bakery products, meat, fish, poultry, vegetables and fruit
CO_2 absorbers	Calcium, sodium or potassium hydroxide	Roasted coffee beans
Substances exhibiting antimicrobial activity	Encapsulated ethanol, silver containing compounds, sorbic and benzoic acids. benomyl and imazalil, lysozyme, bacteriocins (nisine, pediocine, lactacine), components of spices/herbs	fats, cereal products
Ethylene absorbers	Aluminum oxide, active carbon, potassium tetraoxomanganate	fruits (apples, apricots, bananas, avocado) and vegetables (carrot, potatoes, tomatoes, cucumbers)
Absorbers of aroma compounds	Citric acid, cellulose esters, polyamide	Readily oxidizable products, e.g. fats in fish products, fruit juices

Packaging absorbing oxygen

Packagings with a system removing oxygen may inhibit or slow down the growth of aerobic microflora (particularly moulds). At the same time they may prevent oxidation of certain food components, e.g. fats. In this type of packaging numerous chemical substances are found, such as iron compounds, ascorbic acid, glucose oxidase, alcohol oxidase and certain unsaturated hydrocarbons. Chemical substances are contained in a small bag, which is placed in the packaging or they may be incorporated in plastic materials (components of a low molar mass are dispersed in plastic during production or this plastic may be laminated with an absorber carrier) [Vermeiren et al. 1999, Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Kačeňák et al. 2005, Kerry et al. 2006, Trzcińska 2006, Dainelli et al. 2008, Lee 2010].

Packaging with a system producing or absorbing CO_2

The presence of carbon dioxide results in the inhibition of growth of aerobic microflora, e.g. moulds. In order to obtain an atmosphere rich in CO_2 the sachets placed in packagings may contain iron carbonate, mixtures of ascorbic acid with acid sodium carbonate or a mixture pf iron(II) carbonate with metallic halides. Such packagings may be used to package fresh meat, poultry, fish and cheeses.

In some cases (e.g. when packaging coffee) carbon dioxide should be removed from the packaging to prevent its deformation or rupture. Calcium hydroxide is a typical absorber of carbon dioxide used in the form of sachets [Vermeiren et al. 1999, Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Czajkowska 2005, Kacenak 2005, Kerry et al. 2006, Lee 2010].

Packagings with a system reducing moisture content

Packagings with a system reducing moisture content are used in the packaging of fresh meat and meat products, and to extend shelf life of fruits (tomatoes, melons) as well as fish and shellfish. The most promising solutions are offered by polymer structures with microchannels used for the transport of diffused moisture particles. Drying agents are placed on the surface of microchannels. Examples here include packagings composed of an outer layer (e.g. polyethylene or polypropylene), constituting

a barrier for moisture from the outside, and an active inner layer (with microchannels), made from polyethylene glycol [Panfil-Kuncewicz and Kuncewicz 2001, Czajkowska 2005, Kerry et al. 2006, Trzcińska 2006].

Packaging with antimicrobial substances

Packaging with substances exhibiting antimicrobial activity may effectively delay the development of certain microorganisms and extend stability of final products. Sachets with microporous material saturated with ethylene alcohol may be used. Slowly released alcohol vapours are deposited on the surface of food and destroy microorganisms. It is used to extend shelf life of biscuits, bread and dried fish products [Vermeiren et al. 1999, Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Czajkowska 2005, Trzcińska 2006]. The list of substances of antimicrobial character used in food packagings includes e.g. organic acids - sorbic and benzoic acids, and anhydrates of these acids, fungicides, enzymes (lysozyme), bacteriocins (nisine, pediocine and lactacine), components of spices and herbs, e.g. cinammic, lauric and coumaric acids, plant extracts e.g. grapefruit seeds, East Indies bluestern, red pepper and camellia [Vermeiren et al. 1999, Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Czajkowska 2005, Trzcińska 2006, Kerry et al. 2006, Zhou et al. 2010, Lee 2010]

In packaging systems involving chemical preservatives we usually face the problem of active agent migration. Packagings with chemical substances usually take a multi-layer structure. The outer layer serves the protective function. The inner layer, the so-called matrix, contains a chemical substance, while the adjacent layer controls the rate of active agent release [Vermeiren et al. 1999, Zmarlicki 2000, Panfil-Kuncewicz and Kuncewicz 2001, Czajkowska 2005, Kačeňák et al. 2005].

Simultaneously with active packagings the so-called intelligent (i.e. indicator) packagings were developed. These packagings are to monitor and supply information on the product, on its quality during transport, storage, retail sale and storage at the household. They contain an external or internal indicator, which supplies information on the history of the packaged product [Czajkowska 2005, Kerry et al. 2006, Otles and Yalcin 2008, Dainelli et al. 2008, Kozak and Cierpiszewski 2010]. Intelligent packagings most often contain:

- Quality indicators,
- Time and Temperature Indicators - TTI,
- Gas Indicators.

Temperature is the most essential factor affecting the rate, which adverse physical and chemical changes and changes caused by microorganisms appear in the food product. The time-temperature indicators (TT) are found in the form of various types of labels attached on the outer surface of a bulk packaging or individual retail unit packagings. Deviations in the intensity of indicator colour, observable with the naked eye, make it possible to recreate changes in temperature during storage, transport and distribution of food. It is particularly important in case of cold stored and frozen food. The system of TT indicators is also applied in packagings of half-finished products to be processed in microwave ovens or conventional ovens. They are also often used as indicators of critical temperature, i.e. temperature required in storage of a specific product [Czajkowska 2005, Kerry et al. 2006, Otles and Yalcin 2008, Kozak and Cierpiszewski 2010].

The composition of gases inside the packaging changes during food storage and it is the resultant of the respiration process in fresh food, gas permeability through the packaging material, the formation of different gases by microflora causing food spoilage and potentially the presence of invisible damage to the packaging itself. Changes in the gas composition are monitored by gas indicators applied as different types of labels. Gas indicators should be applied particularly in packaging of food stored in modified atmosphere. Most typically indicators of oxygen content are used, while indicators of water vapour, carbon dioxide, ethanol, hydrogen sulfide or other gases are used relatively rarely. Recently it has been attempted to design intelligent packagings with biosensors - "intelligent" devices comprising a bioreceptor recognizing an enzyme, antigen, microorganism, hormone or nucleic acid and

a transductor (of the electrochemical, optical or acoustic type), closely related to the specific character of the measured parameter. The focus is on biosensors, which may be placed inside the packaging or which may be directly linked to the food packaging itself [Czajkowska 2005, Kerry et al. 2006, Otles and Yalcin 2008, Kozak and Cierpiszewski 2010].

The best known intelligent label indicating the content of oxygen inside the packaging is Ageless Eye. In the presence of oxygen a redox reaction occurs and an appropriate indicator displays the result. A high oxygen content may suggest a lack of tightness of the packaging, as well as potential bacterial contamination. An intelligent packaging may also serve the function of a controller in the active packaging, indicating appropriate operation of the active agent, e.g. an oxygen absorber.

In Poland the application of indicators is becoming increasingly popular, particularly in the brewing industry. Such breweries as Browary Żywiec and Browary Lech advertise their use of intelligent labels with changes in the thermochrome pigment as indicators. The moment a desirable temperature is reached, a notice appears on the label indicating that the temperature of beer is optimal for consumption.

FOOD SAFETY HAZARDS DURING THE PACKAGING PROCESS

Biological (microorganisms), chemical (reside of hygienic treatments, microbial origin substances) and physical factors (pieces of packaging, machines and devices, sand, hair, jewelry, buttons) during the packaging process may cause health hazard or threaten the maintenance of product quality.

The biggest hazard is posed by physical factors. Such raw materials as raw meat, fats and sauces are at the highest risk of microbial contamination. They require adequate temperature, moisture content, limited access to oxygen and light. Storage conditions of these products additionally promote proliferation of harmful microflora. In order to enhance stability microbiologically unstable raw materials should be preserved using physical or chemical methods (meat, fish, ready-to-eat products) or processed (an addition of appropriate substances, pH modification, etc.) or subjected to the packaging process. Thus first of all the preservation process in the packaging and packaging of preserved food cause considerable reduction of hazards for the final product. In the other cases the packaging process becomes a stage in food production, in which quality and safety of the product are at risk. For this reason packaging usually becomes a critical control point (CCP).

In the packaging process the biggest threat for product safety is posed by contacts with:

- Non-sterile packaging materials (secondary contamination from handling operation facilities by workers),
- Contaminated surfaces on the production line (design of machines and equipment),
- Air in the facilities where the process is run,
- Personnel (the number and state of hygiene of the personnel).

SUMMARY

The packaging of the product has an important role in the protection of the stability of the final product. It is particularly important for products subjected to external factors, especially for food products. The new methods of packaging (e.g. intelligent packaging) are very suitable but also very expensive. The aim of this paper was to list all advantages and disadvantages of packaging used for meat products. Such list enables to choose the optimal type of packaging for given asortment of food and specific conditions of the transport and storing.

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SYSTEMY PAKOWANIA ŻYWNOŚCI POCHODZENIA ZWIERZĘCEGO

STRESZCZENIE. Głównym zadaniem pakowania żywności jest ochrona produktu w trakcie przechowywania i transportu przed działaniem czynników biologicznych, chemicznych i mechanicznych. W pracy przedstawiono systemy pakowania żywności pochodzenia zwierzęcego. Scharakteryzowano pakowanie próżniowe i w atmosferze modyfikowanej oraz nowe typy opakowań, określane terminami „opakowania inteligentne" i "opakowania aktywne".
Celem opracowania było zestawienie zalet i wad opakowań stosowanych dla wyrobów mięsnych. Zestawienie to umożliwia wybór opakowania optymalnego dla konkretnych asortymentów oraz konkretnych warunków transportu i przechowywania.

Słowa kluczowe: pakowanie próżniowe, pakowanie w atmosferze modyfikowanej, opakowanie aktywne, opakowania inteligentne.

VERPACKUNGSSYSTEME FÜR FLEISCHERZEUGNISSE

ZUSAMMENFASSUNG. Die Hauptaufgabe von Lebensmittelverpackungen ist der Schutz der Waren während der Lagerung und des Transport gegen die Wirkung der biologischen, chemischen und mechanischen Faktoren. Der Artikel stellt die Verpackungssysteme für Fleischerzeugnisse vor. Solche Verpackungssysteme wie die Vakuumverpackung, die MAP-Verpackung und die neue so genannte „intelligente Verpackung" und „aktive Verpackung" wurden gekennzeichnet.
Das Ziel dieser Arbeit war, alle Vor- und Nachteile von Verpackungen für Fleischerzeugnisse zusammenstellen. Solche Zusammenstellung ermöglicht die optimale Verpackung für das gegebene Warensortiment und für spezifische Bedingungen des Transport und der Lagerung zu wählen.

Codewörter: Vakuumverpackung, MAP-Verpackung, „intelligente Verpackung", „aktive Verpackung" .

Agnieszka Bilska
Instytut Technologii Mięsa
Wydział Nauk o Żywności i Żywieniu
Uniwersytet Przyrodniczy w Poznaniu
ul. Wojska Polskiego 31, 60 - 624 Poznań
tel. +48 61 846 6086
e-mail: abilska@up.poznan.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 1
No 5

http://www.logforum.net

OPERATIONAL CONTROLLING - A TOOL OF TRANSLATING STRATEGY INTO ACTION

Bogusław Śliwczyński

Poznan School of Logistics, Institute of Logistics and Warehousing, Poznań, Poland

ABSTRACT. Enterprises have a lot of problems with realization their strategic aims in the fast changing and competitive business arena from many years. Effective execution of strategic plan needs its translating into action, task results and indicators of everyday activities. The success on the market is attainable by communicating strategic and operating goals on the each level of organizational structure and their connecting with budget of units or employee motivation. The scorecards balancing in finance, customer, process and development perspectives is very useful for pointing - what do we control with? or - what do we have to achieve? But doesn't answer to question about ways of enterprise managing.
Main aim of the article is proving that operational controlling system is a essential tool for translating strategy into action. The Balanced Scorecard methodology should to take into consideration system and process connection of enterprise with procurement, co-operation or distribution supply chain also.

Key words: controlling, operational strategy, balanced scorecard, process management, supply chain.

INTRODUCTION

Taking into account the practical aspect of functioning of enterprises, there often occur the lacks of the adjustment of the process architecture to the development strategy, which in a long run may result in the impossibility of executing the assumed strategy [Cyfert 2007]. Controlling instruments - supporting planning, controlling and steering - make possible to transform the results of economic forecasts and strategic simulations to the level of the current product supply chain management. The results of the research conducted in many research centres [Gadiesh, Gilbert 2001] show that around 50% of strategies are not implemented into economic practice, either totally or partly. The results of the research, regarding ineffective execution of strategies (table 1), conducted by the author of this paper confirm insufficient communication of a general strategy with actions taken on the level of execution.

The analysis of the conducted study (table 1) allows formulating the following general conclusions:

- Having a general strategy is not sufficiently effective to achieve the goal - because the strategy should be known and understood by the management staff at large, controlled on different levels of management and communicated with processes being realized, management system and enterprise organization,
- Everyday operational actions are often taken without any link to the strategic plan - this plan should be transformed into target values and measures assigned to them as well as into plans, current activities and their budgets,

Citation: Śliwczyński B., 2011, Operational controlling - a tool of translating strategy into action. LogForum 7, 1, 5
URL: http://www.logforum.net/vol7/issue1/no5
Accepted: 14.01.2011, on-line: 21.02.2011.

- Organizations control progress in the achievement of strategic goals by means of aggregating results on the level of operational activities insufficiently - and this is very important when it is impossible to achieve the assumed goals and actions should be corrected [Gadiesh, Gilbert 2001] (the authors quote the 80-100 rule which says that it is better when a strategy that is 80% right is 100% implemented than one that is excellent and 100% right but is not implemented in the enterprise),
- Execution of the general strategy is controlled on the level of the coherency of individual functional strategies to small degree (e.g. sales, production, logistics),
- Competitiveness of an enterprise requires operational ability to respond to consumer's needs - and only few enterprises have a developed operational strategy as a derivative of the general strategy.

The study was conducted in the years 2007-2009 via audits in 92 enterprises and by means of an interview and opinion poll among managers of 176 enterprises. The study was conducted in 4 sectors - automotive, building, apparel and household devices - in production and retail sector, with an even quantitative distribution in the group of small, medium and big enterprises.

Table 1. Results of the research regarding indirect causes of ineffective execution of strategies
Tabela 1. Wyniki badań dotyczących pośrednich przyczyn nieefektywnej realizacji strategii

Indirect causes of ineffective execution of strategies	Percentage share of studied enterprises
Strategic plans are not transformed into operational actions and communicated with middle- and short-period plans	42,0%
Strategic plans are not reflected in balanced target values and measures in from the perspective of the Strategic Scorecard, they are not transponed into processes and planned action budget	51,7%
Enterprises periodically control the coherency of individual functional strategies (e.g. sales, production, logistics) with respect to the execution path of the general strategy	43,0%
Execution of the general strategy is communicated with operational results, management system and organization of an enterprise from the point of view of processes	39,6%
Enterprise has a developed operational strategy as a derivative of the general strategy	37,3%

Source: Own study.

Table 2 includes the results of the research regarding direct causes of ineffective execution of strategies. In many instances, the results confirm the lack of or insufficient use of operational controlling in the management process of activities both on the strategic and operational level. The study was conducted in the years 2007-2009 via interviews and operational audits in 84 enterprises and by means of an interview and opinion poll among managers of 95 enterprises.

Non-flexible processes in the supply chain, problems with the comprehensive coordination of operational activities or barriers in the supply chain regarding cooperation with partners often result from the lack of operational plans of supply chain management (on the strategic and operative level) responsible for the execution of the goals of the general strategy of the enterprise (Table 2).

With a high variability of the economic environment and unstable conditions of functioning of the supply chain over 70% of strategies referred to operations creating product value (mainly strategies focused on achieving competitiveness) are not implemented, either totally or partly. According to the results of the research conducted by Ventana Research (2006) [Sales and Operations Planning Research Study 2009] only 26% of enterprises identify the goals of the S&OP plan as an ordered set of operations realizing the assumptions of the strategic plan. Main causes include:

- Lack of or insufficient control of operations creating product value on the level of operative management and a weak communication of the responsibility for the product within the organizational structure of the enterprise,
- Lack of transmission of the strategic plan into current operational activities plans and goals as well as budgets assigned to them,

– Lack of instruments aimed at controlling strategic goals through multi-sectional aggregation of mutually dependent results of operational activities, this is very important when the achievement of the assumed targets in particular internal and external conditions is not possible and it is necessary to correct these activities.

Table 2. Results of the research regarding direct causes of ineffective execution of strategies
Tabela 2. Wyniki badań dotyczących bezpośrednich przyczyn nieefektywnej realizacji strategii

Direct causes of ineffective execution of strategies	Percentage share of studied enterprises
Non-flexible distribution processes in relation to identified needs of sales as well as the lack of the required flexibility of production and procurement processes	100 %
Numerous and strong competition for chosen products and in the markets chosen by an enterprise	95 %
Costs and risk significantly higher than planned in the business plan when developing the strategy	91 %
Lack of sufficient knowledge about the market and competition leading to overinvestment and the lack of capital or underinvestment in the required time	87 %
Barriers in the supply chain regarding cooperation with recipients (sales networks), suppliers and cooperating enterprises	86 %
Problems regarding comprehensive coordination of many various processes in the supply chain of a product leading to a low customer service and loss of orders	84 %
Lack of the required functionality of an IT system, available and adjusted information making it possible to control the process of executing the strategy	79 %
Insufficient working capital, long payment deadlines by clients and freezing of capital in the stock of materials and products	77 %
Lack of sufficient knowledge about partners and operational cooperation conditions in the supply chain	76 %

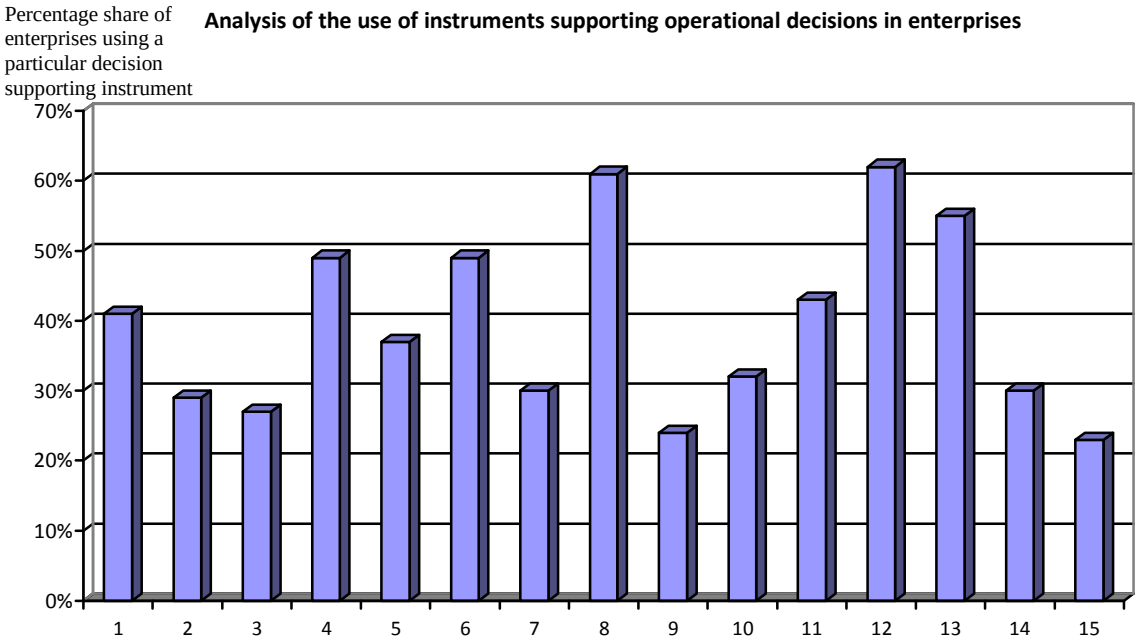
Source: Own study.

The scope of variant and multi-criteria operational analyses on the strategic level presented in chapters 1-3, extended with the verification process of the assumptions of operational management for the required competitiveness of the product and return on investment, confirms the systemic meaning of operational controlling for the effectiveness of the execution of each strategy. The results of the studies conducted in Polish enterprises and by many research centres worldwide show that instruments of management accounting and financial analysis are insufficient from the point of view of effective implementation of competitive strategies (It was conducted via internal audits in 42 enterprises and by means of an interview and opinion poll among managers of 85 enterprises. The study was conducted in 4 sectors - building, apparel, petrol and cosmetics - in production and retail sector, with an even quantitative distribution in the group of small, medium and big enterprises). On this basis, the author formulated the following hypothesis saying that:

Product value oriented strategy requires to be supported by an operational controlling system because it is operations leading to production and provision of a product to a client that are the basis of creating value for the client.

Difficulties with transforming the results of analyses of many economic data into the formation process of operations and assets linked through relations in the supply chain significantly influence the position of operational controlling among other instruments aimed at supporting decisions in the management process of the enterprise [Kuc 2006] (this was also confirmed by the results of the research conducted by the author including the results of the study of the applied methods and controlling algorithms as well as organizational solutions. The scope of the applied controlling instruments (or their elements) in individual operational fields of supply chains on the level of strategic and operative management was also the subject of this analysis). Within the space of the last

20 years an increase in the use of tools supporting operational decisions has been visible, however, the results of the research conducted among 142 enterprises (chart 1) point out that the process of building organizational maturity in this respect is quite slow (based on results of the author's own study conducted within a research project: Development of a universal pattern of logistics controlling solutions for Polish enterprises and their supply chains. Poznań 2009).



Operational decision supporting instruments in enterprises (1-15 according to the order presented in the table below)

No.	Operational decision supporting instruments in enterprises	Percentage share of enterprises using a particular decision supporting instrument
1	Balanced Scorecard and techniques related to cascading strategic goals into operational management fields in the supply chain	41%
2	Account of the results of operational decisions, e.g. inventory level and allocation, production batch volume, transport routes	29%
3	Comprehensive analysis of the supply chain as a profit centre (connection between scenarios related to operational activities and the results of the centres responsible for costs and income)	27%
4	Variant analysis (scenario-related) of allocation of inventory in the supply and distribution chain (including VMI, SMI). Calculation of costs per : products, clients and sales regions, processes, distribution channels	49%
5	Calculation of costs per : products, clients and sales regions, processes, distribution channels	37%
6	Analysis of working capital	49%
7	Budgeting methods on the basis of updated operational normatives	30%
8	ABC analysis of: *products* (on the basis of sales income or profit in connection with ABC classification of recipients and sales channels) *materials* (on the basis of purchase costs in connection with suppliers classification)	61%
9	XYZ analysis of product flow stability (including demand), materials (including consumption, material requirement), loads. XYZ analysis of the stability of the demand for assets	24%
10	Analysis of bottlenecks regarding the flow of products and materials (including pile-ups, stoppages and queues)	32%
11	Mapping, analysis and design and reengineering of processes	43%
12	Scenarios related to balancing resources and workload, schedules and timetables with the use of Gantt charts	62%
13	Factor operational analysis (e.g. related to productivity, efficiency, utilisation level, capacity, customer level, delivery reliability in the supply chain - OTIF)	55%
14	Analysis of material safety – connection between material index and the number of suppliers, conditions of purchase contract and safety stock	30%
15	Audit of operational management of the supply chain (comprehensive evaluation of competitiveness potential)	23%

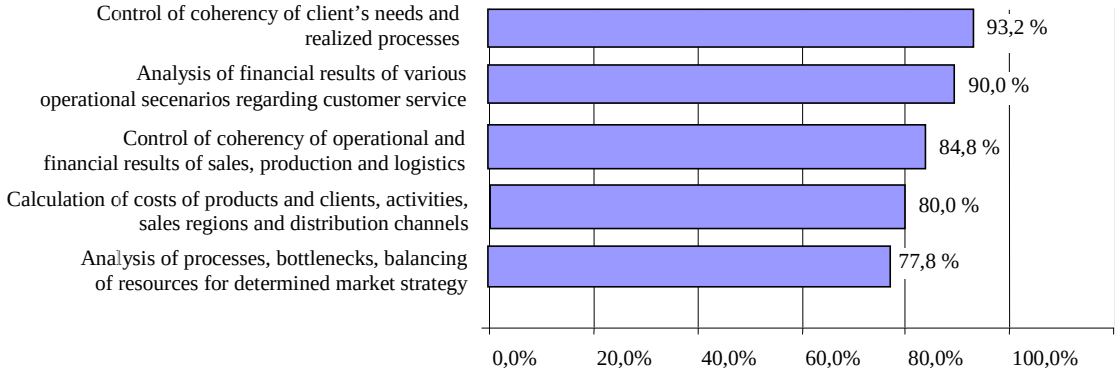
Source: own study.

Chart. 1. Analysis of the use of instruments supporting operational decisions in enterprises
Schemat. 1. Analiza zastosowania instrumentów wspomagających decyzje operacyjne w przedsiębiorstwach

The need for a systemic analysis of the influence of the adopted methods and scenarios on the performance of an enterprise has been the reason for a big interest in operational controlling instruments in Germany, Austria and Switzerland [Weber, Schäffer 2008]. Economic transformations in Poland in the 90-ties, being the result of liberalization of economics, technical progress and the development of competitiveness on the national and world markets opening at that time led to changes in the way enterprises make use of financial and non-financial information. Low use of tool enabling operational decisions presented in table 1 is according to many managers caused by:

- Lack of knowledge about tools enabling decisions and possibilities to use them in the field of operational management (the degree of the use of financial controlling instruments is much higher),
- Low awareness of the need for a systemic management of enterprise efficiency and supply chain processes among management staff,
- Lack of determination among the management and time and money for implementing suitable tool supporting decisions for the enterprise,
- Lack of organizational structures responsible for including tool in the process of operational management,
- Difficulties in obtaining suitable operational data from IT systems,
- Difficulties in integrating operational tools with financial-accounting systems.

According to the opinion of managers in the examined enterprises, instruments regarding financial and management accounting are insufficient to transmit financial and market plans into operational activities, including various scenarios of processes in the supply chain at the same time. The results of the study presented in chart 2 confirm the need for analysing and controlling coherency of market and financial results with the formation of operational activities (based on results of the author's own study conducted within a research project: Development of a universal pattern of logistics controlling solutions for Polish enterprises and their supply chains. Poznań 2009).



Source: own study

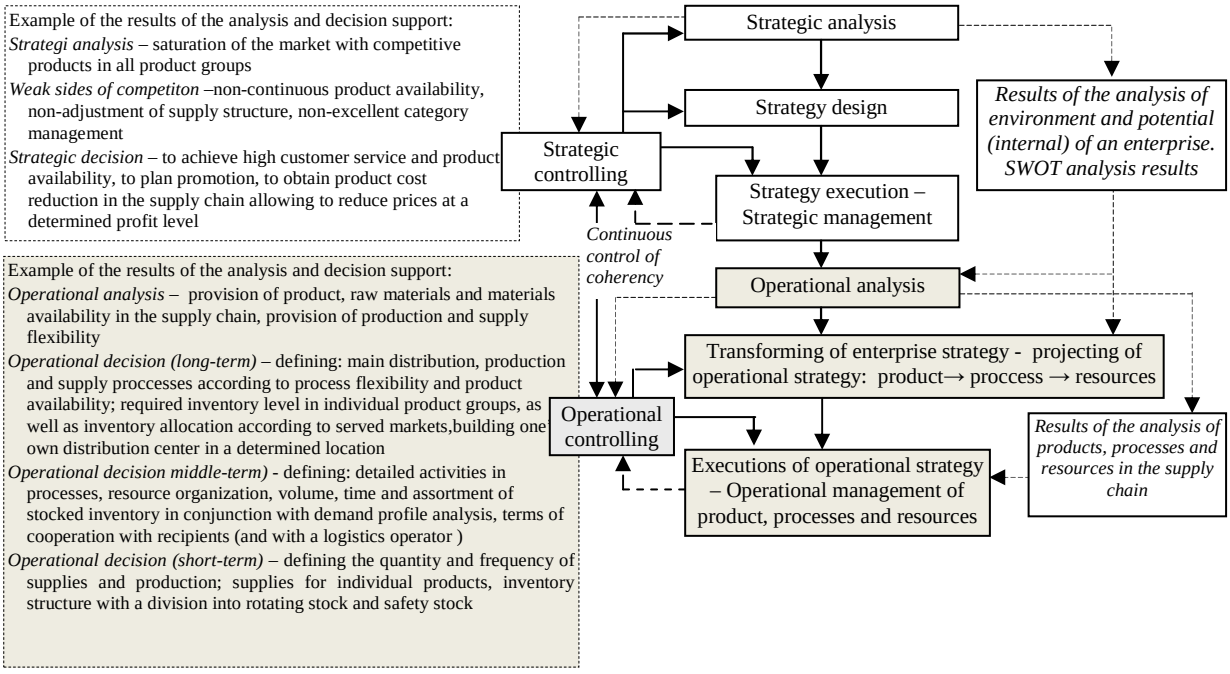
Chart. 2. Results of study regarding the need for analysis and control instruments related to market, financial and operational results in enterprises
Schemat. 2. Wyniki badań dotyczących potrzeb instrumentów do analizy i kontroli odnoszących się do rynkowych, finansowych i operacyjnych wyników przedsiębiorstw

Selection of steering methods regarding procurement, production and distribution processes as well as organizational solutions for the supply chain, in accordance with cost reduction plan and result improvement, is a very common problem. In the examined enterprises, problems regarding identification of weak market signals and adjustment of operational management methods to increasing rapidity of changes within market environment and decreasing predictability of results were indicated.

ASSUMPTIONS OF TRANSFORMATION - BALANCING GOALS

Transforming the strategy into activities should take place with the maintenance of the imperative of connecting individual functional activities into a coherent system aimed at generating value. The authors of the Balanced Scorecard - R.S. Kaplan and D. P. Norton - presented a proposal of connecting goals with measures through balancing these goals and a logical analysis of network relations in four perspectives [Kaplan, Norton 2002]. On the basis of an analysis of a balanced development of an enterprise, the following perspectives can be distinguished: the one of a client and the one of a product. The authors suggest that one should determine strategic goals for each perspective resulting from a general strategy of an enterprise, transform them into values of measures regarding goal achievement and necessary activities. The basic four perspectives should only be treated as a framework and not a rigid pattern to be applied. The number of perspectives may vary (most frequently between 3 and 5), depending on the kind and scope of functioning of an enterprise, its environment and characteristics.

A general strategy positions an enterprise on the market, defining among others goals of functioning of en enterprise, product and market, competitive position, development directions and market diversification level, organizational structure, customer and supplier relations, product manufacturing technology, etc. Picture 1 presents fields of support of individual management levels in an enterprise by strategic and operational controlling.



Source: Example deriving from diagnostic research regarding principles of controlling

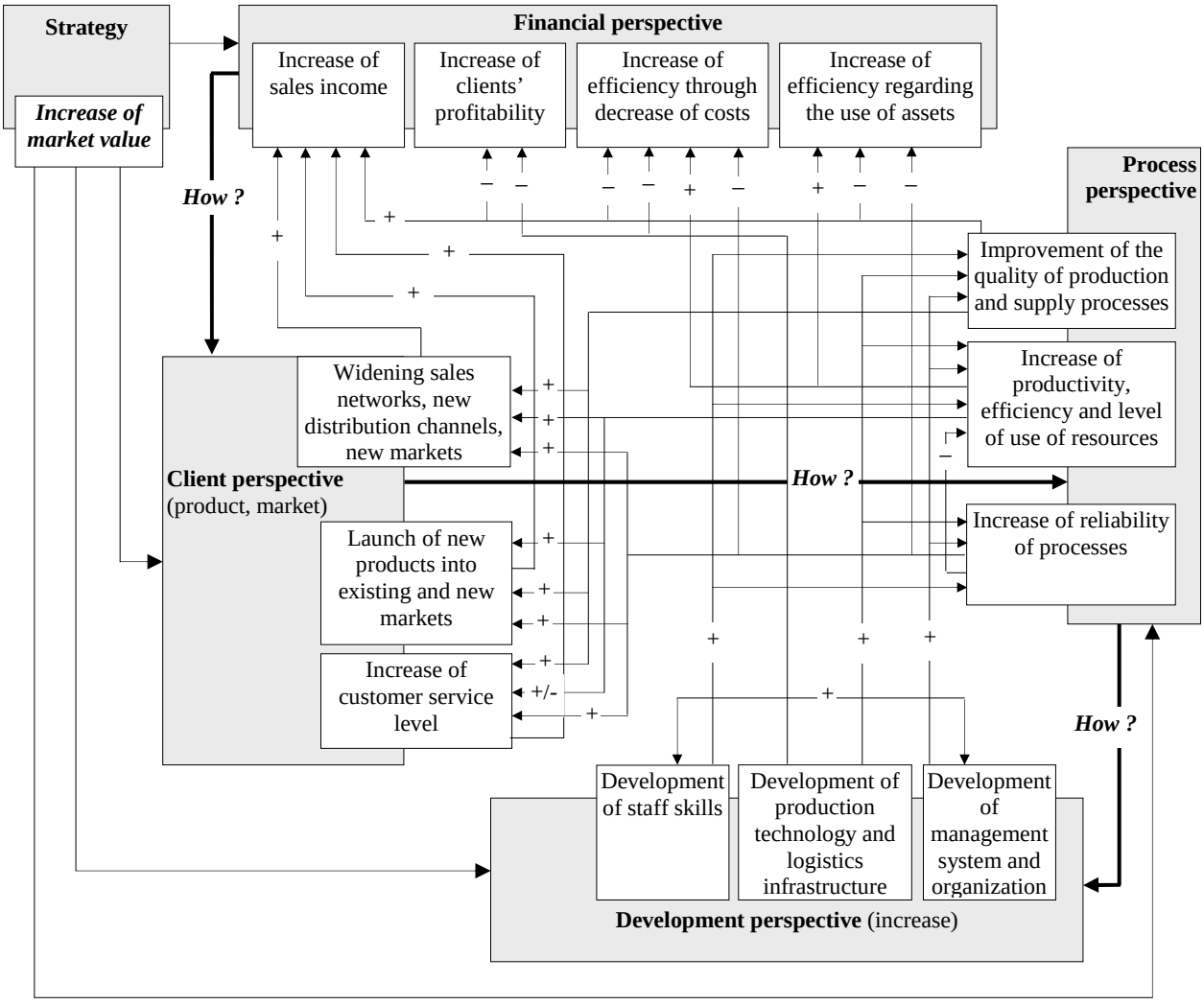
Fig. 1. Position of operational controlling in the process of strategy execution
Rys. 1. Umiejscowienie controllingu operacyjnego w procesie realizacji strategii

Balanced measurement of operational effectiveness is at the same time an instrument aimed at translating strategy into action. Operational strategy includes designing products, their manufacturing processes, supply chains and resources as well as mutual relations between them thanks to which it is possible to achieve goals of the general strategy. In this respect, operational controlling supports:

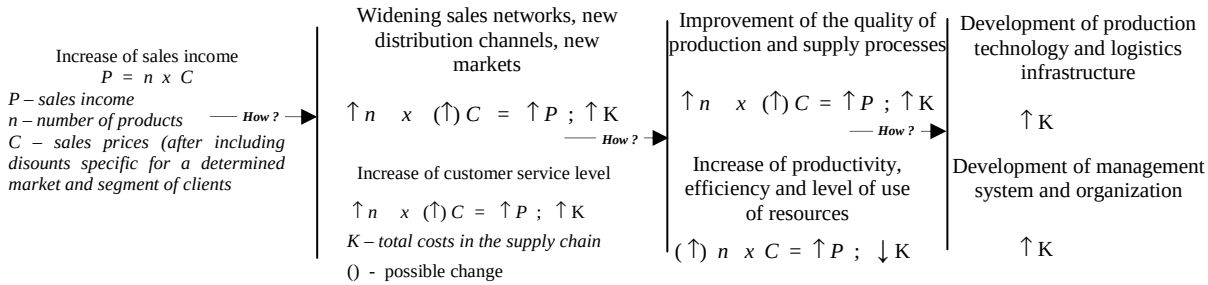
- Process management starting with determining main processes and their location (e.g. in an enterprise or subcontractor within the confines of outsourcing) through process design,
- Assignment and allocation of resources in processes,

- Process controlling,
- Change management and process improvement.

Balancing the goals of an organization in individual perspectives is reflected in relations between values of goal measures on the strategic level (Strategic Scorecard). A strategy is a set of hypotheses where occur casual-effect dependencies and the link between goals and actions as well as the organization of goal achievement are of a network character (Picture 2).



Example of a balance of a total influence on strategic goal execution



Source: own study

Fig. 2. Example of translating strategy by means of balancing goals in a scorecard
Rys. 2. Przykład tłumaczenia strategii poprzez metody celów bilansowych w strategicznej karcie wyników

System of controlling in the process of measuring efficiency shows relations between goals and values of measures assigned to them in various perspectives so that it is possible to manage and verify them.

Actions taken in client, process and development perspective presented in picture 2 results from financial goals and determine profits gained in financial perspective. The logic of balancing goals within a scorecard usually takes place in an iterative manner from financial goals (e.g. increase of sales income), through next planned requirements (goals and actions) in client perspectives (e.g. increase of customer service level), processes (e.g. increase of process reliability) and development (e.g. increase of organization and management system), enabling to achieve them. From the practical point of view, this means verification of goals in a feedback loop because only balancing the total influence of adopted solutions determines enterprise profit. Mapping of strategic goals (e.g. need for the improvement of market value of an enterprise or product value for the client and the enterprise) makes it possible to link the goals determined for various areas of functioning of an enterprise into one coherent system, by means of defined causal-effect relations. Balancing the goals in various perspectives decreases the risk of favouring and manipulating priorities of achieving them. This eliminates situations in which e.g. improvement of customer service level focused on the increase of income may lead to uncontrolled cost escalation. Aims to reduce costs and investments for technology development may limit sales income and chances for profit in future.

Balancing the goals in the scorecard is a controlling instrument in the process of operationalization of the strategic plan. The results of the conducted research show that:

- Only around 41% of examined enterprises use the scorecard as an instrument aimed at supporting operational management decisions,
- Around 50 % of examined enterprises do not project strategic plans in balanced values of goals and measures of individual perspectives of the strategic scorecard and do not transform them into processes and actions,
- Only around 40% of examined enterprises communicate the general strategy with results of processes, management system and organization of the enterprise.

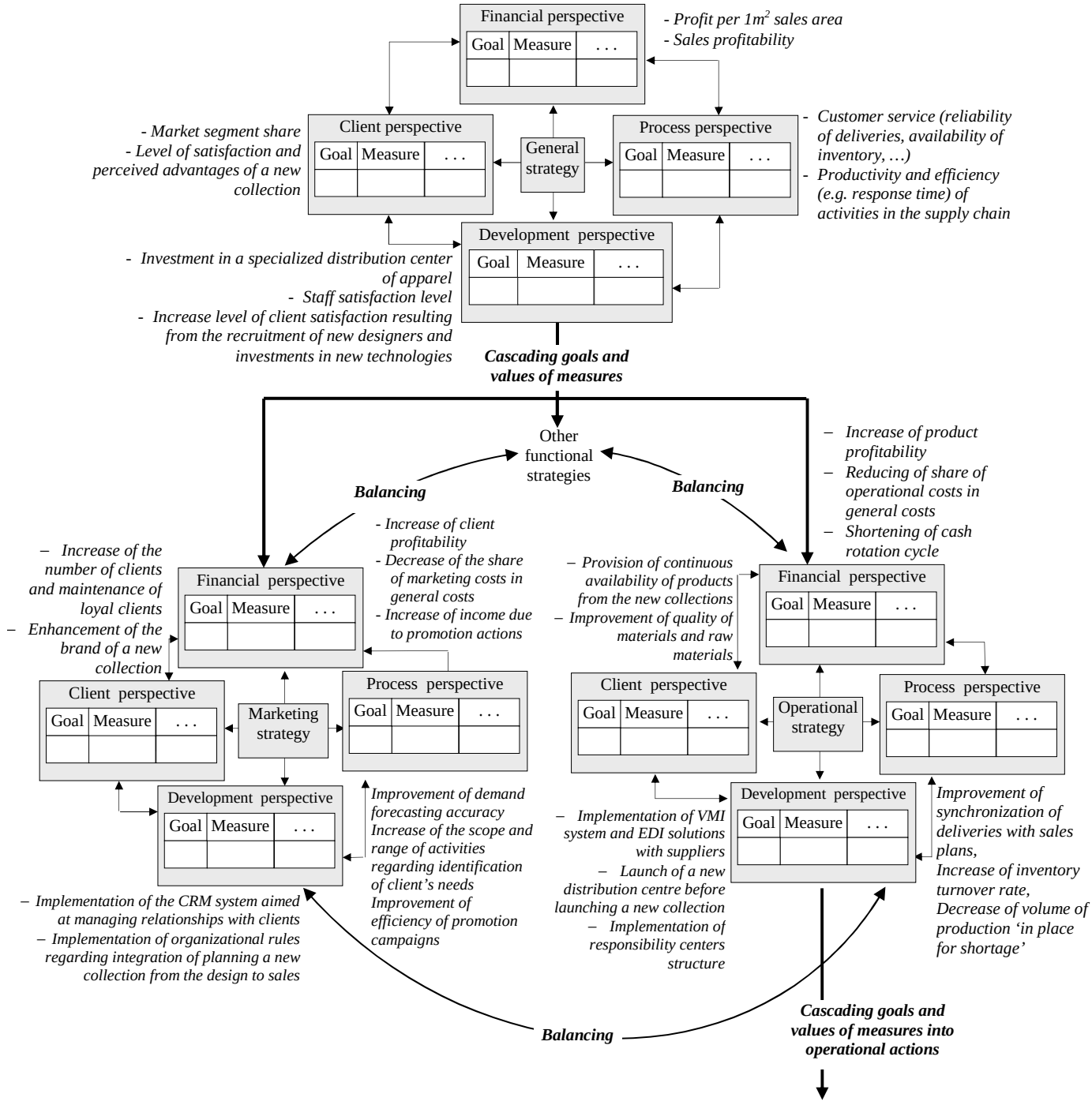
The result of balancing the goals of the strategy requires cascading their planned values and adopted actions into the level of functional strategies (e.g. marketing, financial, operational).

TRANSFORMATION OF GOALS INTO ACTIONS

The process of cascading includes projecting the goals of the operational strategy in realization of individual processes in the supply chain [Kaplan, Norton 2001]. Balancing the values of goals and measures and coordination of actions in individual processes of operational activities is the basic of coherency and integration of processes and their mutual synergy. Each enterprise has its own chain of creating the value, specific for its product, resources and closer and more distant market environment. A general model of the value chain includes three basic process groups [Kaplan, Norton 2002]:

- Innovative processes - investigation of client's needs, product design and development,
- Operational processes - product manufacturing and delivery,
- After-sale service processes - actions taken for the sake of value for the client after sales and provision of the product.

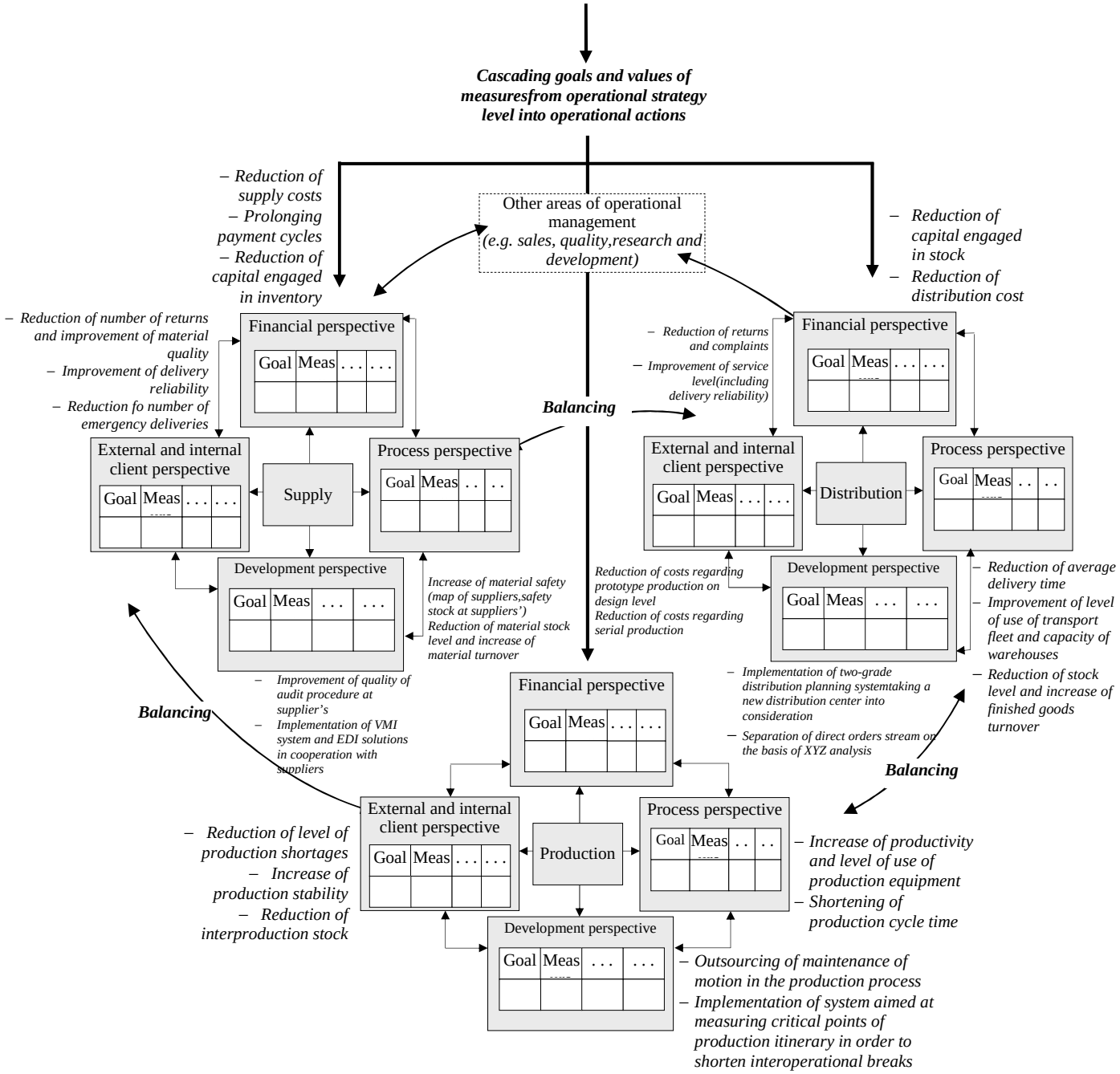
The second and third group also include actions regarding the process of withdrawing the product from the market, replenishing the inventory in the whole life and management cycle of the product. Pictures 3a and 3b present an example of use of the balanced scorecard and the mechanism of cascading operational strategy into the level of processes in the supply chain for one of the examined enterprises from the apparel sector when launching a new collection.



Source: Own study on the basis of the results of the research

Fig. 3a. Example of the use of mechanisms of balancing and cascading the results in the process of transforming strategic goals into the level of functional strategies

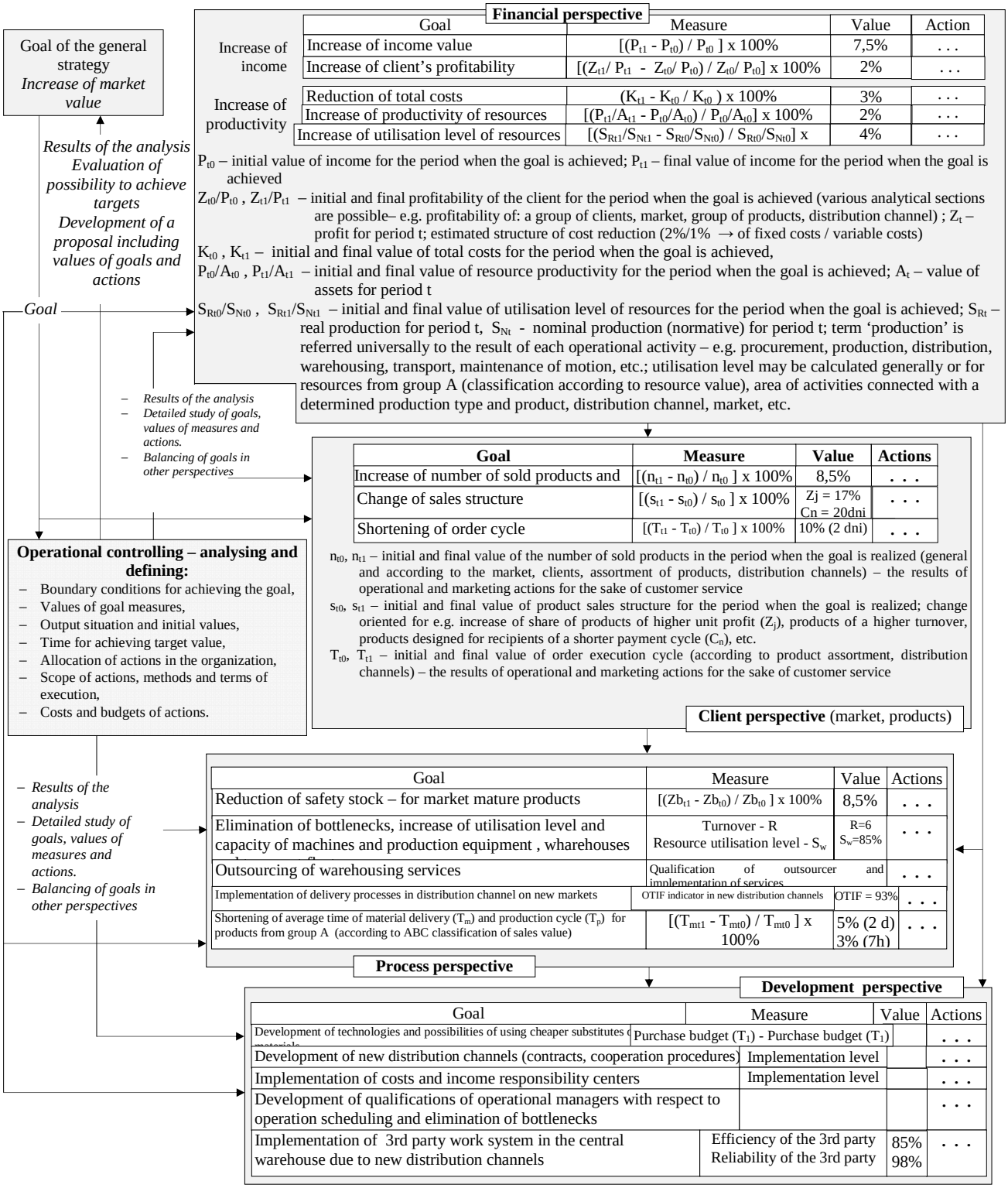
Rys. 3a. Przykład zastosowania mechanizmów balansowania i kaskadowania wyników w procesie przekształcania celów strategicznych na poziom strategii funkcjonalnej



Source: Own study on the basis of the results of the research

Fig. 3b. Example of using balancing and cascading mechanisms in the transforming process of operational strategy goals into the supply chain level processes of apparel products

Rys. 3b. Przykład zastosowania mechanizmów balansowania i kaskadowania wyników w procesie przekształcania operacyjnych celów strategicznych na poziom procesów w łańcuchu dostaw produktów odzieżowych



Source: Own study on the basis of the results of the research

Fig. 4. An example of operational controlling support in the process of transforming general goals into the supply chain level of processes

Rys. 4. Przykład zastosowania controllingu operacyjnego w procesie przekształcania celów ogólnych na poziom procesów w łańcuchu dostaw

Balanced scorecard is a controlling instrument and network analysis methodology is used to develop a coherent logic construction of the assumptions of the controlling system supporting operational decisions. Each strategy requires balancing their own goals in individual perspectives and defining coherent relations with the goals of other strategies and the goals of the values of the superior strategy. That is why the size of the promotion campaign regarding the launch of new products into the market should include process capacity and efficiency of distribution channels and campaign costs should be included from the point of view of a negative influence on the profitability of products and clients. Balancing includes the goals and values of all factors of operational management - of a product, client, financial results as well as processes and resources - agreeing to significant degree with the perspectives in the scorecard. Processes related to implementing the balanced scorecard at Zespół Elektrociepłowni Bydgoszcz S.A., Nestle Polska and Kompania Piwowarska S.A are examples of translating operational strategies into tasks regarding operational management.

Measures placed in the scorecard are the elements of the chain of casual-effect dependencies and explain the logic of transforming the strategy of an enterprise into operational actions. Dependencies between measures included illustrate their influence on the execution of financial goals. Calculating quantified values of goal measures, defining the scope of actions and defining their execution costs are factors determining the efficiency of balancing the card. That's the source of the tasks of operational controlling completing the data from the balanced scorecard and including actions aimed at defining:

- Boundary conditions (external-market-oriented and internal-organization-oriented) for realizing tasks and achieving the goal,
- Values of goal measures or description of the target state in case of immeasurable goals,
- Output situation and initial values,
- Time to achieve the target value,
- Allocation of actions in the organization on the basis of a operational audit, process measurement, ABC analysis, sensitivity analysis, etc., for the sake of the evaluation of reality, investment and rapidity of achieving the goal,
- Scope of actions, methods and parameters as well as the conditions of execution,
- Costs and budgets of actions.

Picture 4 depicts an example of supporting the achievement of goals included in the scorecard through operational controlling.

Complementary data of the scorecard makes the vision of achieving the goal real, making it possible to verify wishful attitude of the management towards the process of achieving the goal in too short time, without determining required actions and terms of execution, without being aware of necessary costs.

CONCLUSION

Supporting to achieve the goal an enterprise requires support within management both on the strategic and operative level. Strategic controlling constitutes a support system for planning, controlling and steering actions being elements of the process of execution the strategy. The scope of variant and multi-criteria operational analyses on the strategic level presented in the article, extended with the verification process of the assumptions of operational management for the required competitiveness of the product and return on investment, confirms the systemic meaning of operational controlling for the effectiveness of the execution of each strategy.

In the authors opinion, transforming the enterprise strategy into operational actions and a continuous verification of compatibility of goals and realized tasks with the enterprise strategy goals should be realized with operational controlling. Both areas constitutes in fact one, tightly connected

and communicated controlling system. Information and methodological support for developing an operational strategy on the basis of a general strategy and verification of coherency and compatibility of operational strategy with a general strategy are important areas of tasks of operational controlling. Operational strategy is defined in litterature regarding operational management in many ways- e.g.:

- "operational strategy constitutes a set of goals, plans and policies determining how operational functions will support the strategy pf a company" [Anderson, Cleveland, Schroeder 1989].
- "operational strategy is a consequent operational decision model supporting the strategy of a company" [Hayes, Wheelwright 1984].
- "operational strategy is a relation between operational decisions and company's strategy" [Skinner 1996].
- "operational strategy is a set of operational decisions conformed to client's requirements" [Hill 1989].

Balanced scorecard is a controlling instrument and network analysis methodology is used to develop a coherent logic construction of the assumptions of the controlling system supporting operational decisions. Based on results of presented studies and analysis author positively verified formulated hypothesis - saying that - product value oriented strategy requires to be supported by an operational controlling system because operations leading to production and provision of a product are the basis of creating value for the client.

Analyses performed in the controlling system allow assessing the coherency of strategic goals and transforming them in the form of requirements into the level of operative actions and communicate the values of strategic goals with the requirements of measure values. In this scope, operational controlling supports verification of strategic diagnosis [Urbanowska-Sojkin, Banaszyk, Witczak 2007] and worked up scenarios as well as control and correction of long-term actions in the process of strategy execution. Operational controlling supports the implementation of the strategy, e.g. transforming the strategic plan into plans of operations on the strategic, tactical and operative level.

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CONTROLLING OPERACYJNY - NARZĘDZIE PRZEKSZTAŁCAJĄCE STRATEGIĘ W DZIAŁANIE

STRESZCZENIE. Przedsiębiorstwa napotykają wiele problemów w trakcie realizacji celów strategicznych w szybko zmieniającym się i konkurencyjnym świecie biznesowym. Efektywna realizacja planu strategicznego wymaga jego przełożenia na działanie, wyniki i wskaźniki bieżącej działalności. Sukces rynkowy jest uzyskiwany poprzez spójność celów strategicznych i operacyjnych na każdym poziomie jednostek czy motywację pracowników. Z punktu widzenia finansów, klienta, procesów i rozwoju Karta Wyników jest bardzo użyteczna w poszukiwaniu odpowiedzi na pytanie: czym kontrolujemy? co chcemy osiągnąć? ale nie odpowiada na pytanie: jak zarządzamy przedsiębiorstwem? Celem pracy było udowodnienie, że metoda controllingu operacyjnego jet istotnym narzędziem dla przetłumaczenia strategii w konkretne działania. Metoda zbilansowej Karty Wyników powinna brać również pod uwagę powiązania systemu i procesu z zakupami, współpracą firmy oraz łańcuchem dostaw. W pracy przedstawiono system controllingowy jako narzędzie do przekształcenia strategii w konkretne działania.

Słowa kluczowe: controlling, strategia operacyjna, balanced scorecard, zarządzanie procesem, łańcuch dostaw.

OPERATIVES CONTROLLING - EIN INSTRUMENT FÜR DIE ÜBERSETZUNG DER STRATEGIE IN DIE WIRKUNG

ZUSAMMENFASSUNG. Die Unternehmen stehen vor vielen Problemen bei der Realisierung ihrer strategischen Ziele in einer sich schnell ändernden und wettbewerbsorientierten Welt der Wirtschaft. Die effektive Durchführung von strategischem Plan erfordert die Übersetzung dieses Plans in die Wirkung, die Ergebnisse und Indikatoren der aktuellen Tätigkeiten. Der Erfolg auf dem Markt ist erreichbar durch die miteinander kommunikativen strategischen und operativen Ziele auf jeden Ebenen der Organisationsstruktur und ihre Verbindung mit Budget von Einheiten oder die Motivation der Mitarbeiter. Im Finanz-, Kunden-, Prozess- und Entwicklungsperspektiven ist Balanced Scorecard sehr nützlich bei der Suche nach

Antworten auf die Frage: wie wir kontrollieren? was möchten wir erreichen? aber nicht bei der Suche nach Antworten auf die Frage: wie leiten wir das Unternehmen? Das Hauptziel des Artikels ist zu beweisen, dass das operative Controlling-System ist ein wichtiges Instrument für die Umsetzung der Strategie in der Tätigkeit. Die Balanced Scorecard Methodik sollte auch System- und Prozessverbindungen von Unternehmen bei der Beschaffung, Zusammenarbeit und Lieferkette berücksichtigen. Der Artikel präsentiert ein Controlling-System als das Instrument zur Übersetzung der Strategie in konkreten Maßnahmen.

Codewörter: controlling, operative Strategie, balanced scorecard, Verwaltung des Prozesses, Lieferkette.

Bogusław Śliwczyński
Poznan School of Logistics
Institute of Logistics and Warehousing
ul. Estkowskiego 6
61-755 Poznań, Poland
e-mail: boguslaw.sliwczynski@ilim.poznan.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 2
No 1

http://www.logforum.net

THE DYNAMICS OF THE POPULATION FLOWS IN METROPOLITAN AREAS

Zbyszko Pawlak

Poznan School of Logistics, Poznan, Poland

ABSTRACT. The article presents an analysis of the dynamics of population flows in the corridors of the metropolitan area, based on the example of Poznan. The aim of these studies was to determine the mobile preferences of the population as well as the possibilities for improving the efficiency of the city transport, mainly in aspects related to the road congestion and its reducing by the better use of the existing railway infrastructure as well as other instruments of the transport policy. The results obtained in multi-methods analysis showed, that such solution is likely to be a successful one as an alternative to the road transport and different strategies and solutions, designed in accordance with articulated preferences of the population, may be more effective than large-scale initiatives issued by a superior. The "difficult" heritage of the poorly used or unused railway infrastructure, occurring in many urban areas, can be often successfully adapted to be a solution for the transportation needs of the inhabitants.

Key words: metropolitan area, city management, congestion, passenger transport, city logistics, transportation, commuting to work, flows of the population.

INTRODUCTION

The spatial development of urban areas and continually growing needs of the population in terms of mobility (to move faster and further) significantly affect the systems of the passenger transport. The fulfilment of these needs and at the same time the minimizing any negative impacts of the transport on the social and economic environment is very difficult and responsible task for many areas of the science. The city passenger transport means not only the transfer of the people in the space, but also a dynamic influence on the entire system of the logistic infrastructure of the city and therefore it became the topic of the interest of researches as well as experts, who optimize the management of city areas. The researches of preferences between means of the transport or traffic routes, the modelling of interactions between users as well as costs and profits analysis make the transport field the research topic mainly for economists and scientists involved in the transport management. The quantitative modelling of transport systems is also an important task for traffic engineers. All these approaches are presented more or less in this paper. The common desire to understand the behaviour and to learn the preferences of the inhabitants, as well as to improve the efficiency of the city transport, mainly in aspects connecting with road congestion, shares all these approaches.

The road congestion is today probably one of the biggest problems of city transport systems. The road congestion, defined usually as the overcumulation of vehicles on the road, could lead to overload of transport network and ultimately to the stop of the flows [Tundys 2008]. One of the proposed solutions for this situation is to provide the alternative public transport system, e.g. rail one, which

Citation: Pawlak Zb., 2011, The dynamics of the population flows in metropolitan areas. LogForum 7, 2, 1
URL: http://www.logforum.net/vol7/issue2/no1
Accepted: 11.04.2011, on-line: 5.05.2011.

could take over some part of persons travelling by cars. Such solutions, increasing the trouble-free flow, are introduced already in many urban areas all over the world. The introduction of such type of a solution is still not fully examined in cities of former socialist countries, where the sudden political and economical transformation of the end of twentieth century increased the problem of the road congestion to the unprecedented proportions. Therefore the aim of researches made and described in the presented paper, is to determine whether the inclusion of existing railway infrastructure of urban and suburban areas could lead to decreasing of the road congestion and obtaining the improvement of management of population flows in existing transport corridors. The extended area of agglomeration of Poznan, so-called Poznan metropolitan area, was chosen to be the area of this research. It consists of the city of Poznan and 17 surrounding municipalities. The population of chosen area is over 850 000 inhabitants [GUS 2010]. The base study was conducted for the selected city within this area in three main transport corridors, associated with flows of the population and extended in north, east and south directions starting from the centre of the city along the existing roads – in the form of roads and railway lines. The peculiarity of the area covered by the research is the constantly congestion problems of the roads system at peak hours while at the same time the railway lines reveal the big reserves – they are not intensively exploited, since the majority of regional transport connections (mainly due to the lack of the profitability) was cancelled in the mid of 90's last century. The considerable part of flows of the population is realized at present by the use of personal cars (e.g. daily commuting to work). It leads to increasing of the congestion in the city and decreasing the average speed of the travel. The metropolitan area of Poznan has well developed and practically poorly operated railway infrastructure, which could be relatively quickly adapted to the needs of the transport system between urban and suburban areas, similar to an existing system in London, Berlin or Paris. Providing such public transport system, based on the already existing infrastructure, could efficiently improve the conditions of the transport of the population both in city area and practically in the whole metropolitan area.

Hence, this research is characterized by the duality of the scientific aim:

- a congitive aspect – to determine the influence of the population flows in the agglomeration of Poznan on the transport infrastructure of the city,
- a utilitarian aspect – to determine in what context and whether the inclusion of the existing urban and suburban railway infrastructure can reduce the road congestion and consequently improve the management of the population flows.

THE DETERMINANTS OF FLOWS OF THE POPULATION IN METROPOLITAN AREAS

The high tendency to the mobility of the population in urban areas and the passengers' flows and congestion problems resulted from this, are related to every bigger urban agglomeration all over the world. It is practically not depended on the level of economical development of the country. The urban areas are the areas created by humans with the participation of environmental, social and economical factors and characterized by the increased density of building, compared to surrounding areas. It is connected with the constant trend of growing number of inhabitants of urban areas in comparing to rural areas. This trend is expected to be continued in the future.

The congestion of the road traffic in the cities is understood as the situation of the accumulation of vehicles leading to the overload of the transportation network as well as many social, economical and ecological problems connected with this [Pawlak 2007].

The passenger transport has been always one of the key subsystem of urban areas [Tundys 2008] fulfilling the needs of mobility of the population [Matulewski et al. 2007]. The significance of the assurance of the realisation of these opportunities has been identified by Peter Hall, as one of the most important factors influencing the convenient conditions of the life. The possibility to travel gives the chance to discover and meet new people and in turn to develop the conditions of the creative environment, where the innovations, art and science could be dynamically developed. While cities and

metropolitan areas has evolved for long periods of time (some of them creating bigger city-regions and some polycentric agglomerations), the passenger transports will remain an indispensable element of their functionality, providing the connection between the densely populated centres and integrating the various functional areas of the city (residential, commercial or recreational one) into one system [Broll 2004, Hall, Pain 2006]. The transport is clearly called by Pawlak [2007] to be the power keeping the cohesion of the city, while Tundys [2008] points out, that transport allows the city to shape and define its metropolitan area (spheres of influences).

The congestion as an occurrence resulting from the division of the cities into the various functional spheres and the need of population's mobility, resulting from that [Domanski 2006] seems to be treated almost as an axiom in the specialist literature [Rodrigue 2006]. However, what is the extent of the researches of this causality justified by empirical researches? While examining the case of commuting to work in Barcelona, Asesnsio [2002] concluded, that the suburbanization is the main reason of the creation of passengers' flows and not only cars flows. Similarly, Luo [2010] showed in his studies the connection between the development of suburban areas and the increased road traffic. The study published by Forbes journal showed, that American cities with large suburbs areas and no public transport system, experience considerable difficulties caused by the high level of the road congestion [Forbes 2010b]. Pawlak [2008] showed, that within the Poznan metropolitan area, towns located closer to Poznan are characterized by higher proportion of transport flows, caused by the high level of commuting of the population to the work. Nevertheless, the results of the researches conducted in Tallinn metropolitan area [Tammaru 2004] proved, that not only suburbanization but also the social and economical system transformation has led the people to change the preferences of the transport, from the abandonment of the public system in the direction to use their own cars, which resulted in the increase of the congestion. It showed the great complexity of this topic and emphasized the importance of this analysis in the context of the system transformations, which have taken place in last twenty years in all post-socialist countries.

The question arising from the assumption, that the commuting to the work is the dominant factor increasing the road congestion, is how this problem can be solved. It seems, that creating more spatially compact cities could be the best option, although it also seems that the change of the rhythm of working time [Down 2004] reducing the number of rides in peak hours could be the solution. Both solutions seems to be quite radical approaches, which require dramatic changes in the process of shaping the urban space, the transformation of social and economical systems as well as the inversion of advanced processes of the decentralization. In the light of such extreme approaches, the rational adaptation of already existing factors creating the urban areas seems to be more probable. Hence, providing the fast, clean and relatively comfortable public transport, which could compete with cars [Rzeczyński 2007], is considered to be the appropriate and realistic solution.

One of the solutions to solve the problem of the road congestion is clearly to change the preferences of as big as possibly numbers of cars' users in the direction of other (alternative) means of the transport. However such advantages of public transport like the safety, the environmental friendliness and higher transport efficiency are well known, it also seems to be important to hear the voices of sceptics, who claim that the influence of the means of the public transport on the total efficiency of transport network of the city could be limited, e.g. by the level of the development of the infrastructure. However, most of the described in the literature study cases for different sizes of the cities, confirms rather the usefulness of the public transport. It was demonstrated based on the analysis of the metropolitan area of Barcelona [Asensio 2002] that suburban trains are able to take over the significant passengers' flows of people commuting to work and therefore to reduce considerably the intensity of the road traffic. The permanent reduction of the number of connections and closing the whole railway lines in the period of last years were undoubtedly the reasons of big problems connected with the road traffic in British urban areas. The commonly used "emergency" programs, aimed mainly to increase the roads' throughput, proved to be greatly a failure. They caused the mass car mobility, which consequently led to the quick increase of the road congestion. On the other hand, the trials undertaken in many metropolitan areas of the rebuilding of the old railway infrastructure into the modern "light" suburban trains led to an unquestionable success – even in such German cities like Freiburg or Hamburg, which now have one of the most effectively operated city transport networks in Europe. The analysis published by Forbes [Forbes 2010a] shows, that the average speed of the car in

Hamburg is 84 km/h, which is almost four times faster than in London (19 km/h) or in Poznan (21,4 km/h) [Bojarski, Kowalski 2008]. However the experiences of many British cities in the eighties of last century, even the economical recession caused the decline of the share of private cars in the total amount of realized commuting rides may suggest, that the years of economical crises can have paradoxically the positive influence on the improving of the efficiency of urban transport systems. The specialist literature offers various ideas and study cases, while often giving practical examples, where they were implemented with the positive or negative effect. However, a simple application of such types of solutions in the cities of former socialist countries remains a topic not fully explored. The consequences of political and economical transformation of the 90's, manifest, among others, in dynamic processes of the suburbanization and the increase of the level of the road congestion – the situation known so far mainly only in the cities of Western Europe or USA [Parysek, Mierzejewska 2006]. The tools to solve such transport problems are mainly very sophisticated and concern large-scale solutions and therefore they are also very expensive [Fularz 2004]. On the other hand, the possibility to adopt the existing railway infrastructure to solve these problems were practically ignored in the former socialist countries, although such solutions were suggested for Wrocław [Antonowicz, Zielaskiewicz 2004], but only for the transport of goods. According to the author, there are so far underestimated but significant possibilities in the metropolitan area of Poznan, to adopt the existing railway infrastructure for passenger transport within the whole metropolitan area.

Summary, many of practical solutions implemented in cities all over the world implies the search for solutions of problems of the road congestion of urban areas towards the greater usage of the public transport, especially the railway transport.

Providing a well-functioning public transport system can be a very useful tool to improving urban systems of the public transport. Nevertheless, only the presence of buses, trams or suburban trains does not lead automatically to increasing the balance between the systems [Richardson 2005]. The expression "sustainability" includes the multidimensional optimization, being a result of long-term interactions of both economical and non-economical factors. The ignoring of these factors, especially the social ones, can lead to the failure of that policy. For example, the drivers in countries, where there is a strong tradition to use their own car, e.g. in USA, will accept less likely the suggestion to use the public transport only due to the reason, the public transport is available. Consequently, it might lead even to the increase of numbers of vehicles on the roads and thereby to the increase of the road congestion. Such situation, so called Braess paradox (the introduction of the additional possibility of transport connection increases the total social cost of the transport), can be a very serious obstacle to the sustainability of the city public transport [Quinet, Vickerman 2004].

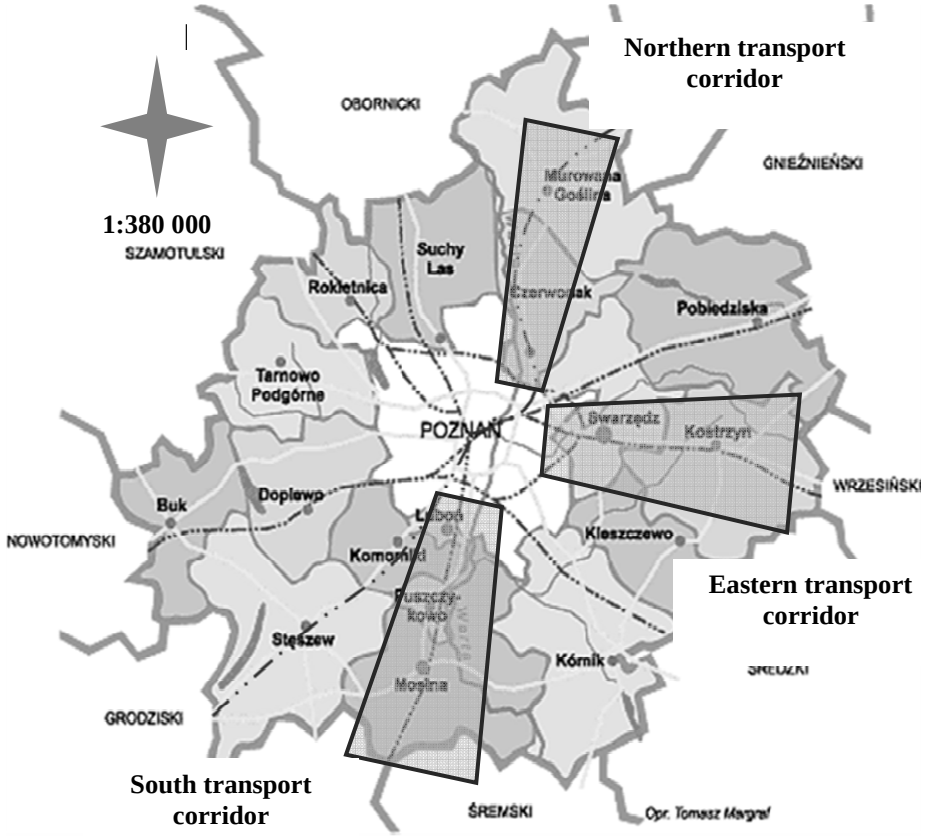
The previous experiences resulted from the rational city management shows, that the public transport is desirable in situations, where the area arrangement minimizes the needs of the mobility of inhabitants, while some researches indicate more the radical vision. The idea of "car-free cities" means that the use of cars is forbidden and only the means of the public transport give the opportunity to travel [Crawford 2000]. It should be pointed out, that if the use of a car is a rational response to existing conditions, it is necessary to provide a rational alternative as well as to inform people about it.

The means of the public transport, despite their abilities to reduce the road congestion, are very expensive projects, even if they are based on the existing infrastructure. The potential failure connected with their wider usage would be significant, and therefore no authority would be willing to accept such situation, especially in the cities of former socialist countries, where the infrastructures resources are still limited. In such case, the post factum analysis of the unsuccessful new projects is unacceptable. The approach ante factum seems to be more appropriate, when the potential users (in this case, commuting to work and schools) are directly asked about their preferences and opinions concerning the proposed transport solutions, including the alternative ones.

THE MANAGEMENT OF INHABINTANTS FLOWS IN METROPOLITAN AREA OF POZNAN

The Poznan metropolitan area is characterized by a very convenient configuration of the transport infrastructure, the high density of the road network and the relatively accessible railway network. Additionally their tracks run often parallel to each other. While the congestion can be observed in the peak hours on the roads, situated along these corridors, the railway lines also situated along these corridors seem to be not used properly. The reduction of local railway connections almost to zero, conducted in 90's of the last century (like in other regions in Poland) is the main reason to the present situation of the lack of the usage of railway lines. Meanwhile, the system of the suburban railway transport, based on existing infrastructure (rail buses, suburban trains), could be certainly a useful alternative to the road system, based on car transport, and consequently leads to the reduction of the road congestion, the unfavourable situation for the whole area.

The research of the dynamics of the population flows were made along three transport corridors of Poznan metropolitan area. These corridors run through the municipalities and towns, where the seats of local governments are located (Fig. 1). There were three reasons for choosing such area of the research: the configuration of the communication infrastructure of the whole region, the availability of data and practical considerations, mainly connected with the possibility of the realisation of further own researches.



Source: own work

Fig. 1. The main transport corridors of population flows in Poznan metropolitan area
Rys. 1. Główne korytarze transportowe przepływów ludności w obszarze metropolitalnym Poznania

The three selected corridors give a very good spatial, environmental, social and economical background to conduct the research of such types of possibilities. The main reasons are: high

population's density of areas, which are under the influence of these corridors (i.e. a lot of potential passengers), the localisation along main roads and railway routes (the easier substitution in the relation car-train) as well as the existence of relatively good infrastructure of train stations in towns situated along the analyzed routes.

The observations made during the conducted analysis of the spatial dynamics of population flows (associated with commuting to work and schools) were, that these flows are the biggest in the morning (between 6 and 10 o'clock) in the south corridor and the smallest in north one. In addition, the flows are cumulated close to the administrative borders of the city, which makes these parts of the corridors more vulnerable to the congestion. It was found, that the most important targets of these flows are the centre of the city (due to the high concentration of workplaces and schools) and the areas located along the corridors already within the borders of the city. It means that besides the commuting to the centre, people also travel at shorter distances – closer to their places of the residence. The probability of such distributions was confirmed by the high value of the Pearson's correlation coefficient (0,958), which confirms the travels made by the use of cars are the main method of the movement of people (60%) among the locations of suburban areas and Poznan. However, in case of the section of the road between Lubon and Poznan (southern corridor), the commuting realised by cars has a smaller share, probably due to the greater availability of good connections provided by public transport (buses and trains). There is also a big share of commuting rides, realised after 10 o'clock, which excludes this group from the test group of commuting to the work or schools. The part of eastern corridor between Swarzedz and Poznan has a fairly big share of commuting rides realised by cars, which can be caused by the good infrastructure (highway), which encourages (raises demand) to use individual rather than public means of the transport.

The importance of such events for transport system of the whole areas is very significant. 75% of total flows of population in all corridors occurs between 6 and 10 o'clock; however, it is even more concentrated in northern corridor, i.e. between 6 and 8 o'clock. The peak hours in the afternoon for this corridor occurs earlier (already before 16 o'clock), while it is more extended in two other corridors and takes place between 15 and 20 o'clock. However, the morning travels between 6 and 10 o'clock and returns (from Poznan) in the afternoon can be regarded as the typical ones for the whole metropolitan area. It also confirms pattern of periodic and regular character of commuting to work and schools in the metropolis, well known from other urban areas [Rodrigue et al. 2006].

The main traffic roads within the corridors (having the bigger throughput than by-streets connected with them) are more preferred than byways and so called short cuts. The highest but still small tendency (app. 25%) to such short cuts is among the users of the southern corridor and the smallest one among those, who use the northern corridor. This discrepancy can be explained by the bigger density of the transport network in the south, and therefore giving the greater possibility to use different routes. Regarding the volume of the road traffic, there are significant differences among corridors, resulting probably from the population density as well as the structure of the transport network of the suburban areas. The similarity of daily cycle of dynamics of the movement of the people to the fluctuation of flows, realized as the commuting to work and schools, seems to be very interesting, with strongly recognized peaks: in the morning (till 10 o'clock) and in the afternoon (between 15 and 18 o'clock). The additional occurrence was observed within the eastern corridor: significantly smaller share of people from the municipalities adjacent to this corridor (24,3%), in comparison to 50,5% in the southern corridor and 55,2% in the northern one. These smaller values result from a greater role of the eastern corridor as a transit route of clearly over regional importance.

Considering the conditions of the road congestion, the average measured speed of the movement was significantly smaller than the speed in conditions of the free movement, which corresponds to so called Relative Delay Rate (RDR), being greater than zero. The worst situation was identified during the morning peak, along the northern and eastern corridors and in the afternoon along the southern corridor – the average speed were half of this under free movement conditions (respectively 31,1 km/h, 42 km/h and 34,4 km/h). It is equal to RDR indicators, having in these cases respectively 100%, 64% and 94%. It means that people spend in their cars while commuting to work and schools twice as much time as in the conditions of free movement for the same distance. It seems also interesting, that in case of the southern corridor, the number of cars in the morning peak hours is higher than in the

afternoon, while delays show the reverse tendency. The reason of such situation is probably the influence of other factors, e.g. changes in the traffic not related to the population displacement. The significant delays were also observed in the morning in the southern corridor and even during the day in the eastern and southern one. In such cases, the average speed fell significantly below 50km/h and thus causing the increase of the RDR indicator over 30%. It means, the throughput of these routes is definitely too small comparing to the roads' load. The average speed of the movement in remaining cases was significantly more than 50 km/h (RDR indicator below 20%), i.e. within the conditions of the free movement (restricted only by traffic regulations). The peak in the afternoon in the eastern corridor was a surprise in this study. It was characterized by lower level of the congestion, which means that (on the contrary to common opinions) the increased level of the traffic does not necessary lead to the delays in the movement of the people. In addition to temporary fluctuations, the RDR indicator showed the spatial diversification, mainly in the area of the northern corridor, where the parts of roads located close to the administrative borders of the city generated bigger delays due to the traffic jams. The explanations of such events should be found in the high accumulation of the flows of vehicles and the control processes of these flows at the crossroads with traffic lights. There were practically no such situations in other corridors, probably connected with the higher throughput of routs, which managed more smoothly the accumulations of the flows of vehicles.

The overview of the present road conditions and the ways of the realisation of the commuting to work and schools in metropolitan area of Poznan showed that the congestion causes the delays of the flows of the population in analyzed transport corridors. The interesting reference to conducted studies is how these commuters perceived this situation. The opinions of the inhabitants of locations within the analyzed area are various, as it could be expected. The inhabitants of the northern corridor are most dissatisfied with the current situation, mainly due to big delays in the morning peak hours. The situation is much better in other corridors, but nevertheless, only the small part of these respondents of surveyed population is actually content about the conditions of their commuting. Many of those people are already used to such situation and do not perceive the current situation negatively.

Based on the conducted researches, some characteristics connected with the intensity and the distribution of commuting to work and the road congestion seem to be convergent. Despite the fact, that the research was done on the bigger amount of data, the strongest relationship was found between the volume of passenger flows and total flows, since up to 98,2% of the variability of first feature was explained by the second one. The gradient of this function describes the value, by which the traffic level increases by every additional individual car, i.e. there is a relation: one individual car to 0,14 vehicle of other type.

The constant coefficient is not reliable in this case, due to its low statistical value ($p>0,05$). On the other side, the relationship between the volume of commuting cars and the traffic level is weaker, but nevertheless the observation can be made, that the correlation between individual cars and total passenger flows is higher. It confirms the assumption, that the change of the amount of people commuting to work can more likely affect the intensity of passenger flows than the total transport flow (which includes also the transport of the goods). Despite the fact, that only the half of the variability is explained by the changes in volumes of commuters using individual cars, it seems important to emphasize, that there are also other factors, like daily fluctuations in transit flow, which can play a significant role.

In addition to relationships between volumes of passenger and total flows, the regression analysis showed also significant connections between commuting and transport flows connected with these rides and the road congestion. The regression analysis, including so-called relative delay ratio (RDR) did not provided promising results, which was shown by high values p and small determination coefficients. On the contrary, the analysis of the average speed gave better results. The constant coefficient for the line of the best adjustment can be interpreted as the speed in the situation of no congestion, although this value (obtained during the regression analysis for 86 km/h) seems to be even too high. It is due to the traffic regulations and some restrictions of the modelling process. In addition, the coefficient of the line gradient describes the value by which the speed of the vehicle will be changed in case an additional vehicle or a person will join the flow. It turned out, that this relationship is rather of logarithmic nature, while the higher determination coefficient (R^2) and the smaller standard

error (S) were obtained for logarithmized date. It means these date fit better than the date without the logarithmic transformation. In other words, the average speed of the vehicle is changed rather as a natural logarithm of the flow volume (the convex dependence) – e.g. the speed of the travel decreases rapidly at the lower unit volume of the rides, which could be interpreted as follows: when the transport flows are bigger, each individual person in the vehicle can affect more the speed of the flow by the reduction of the actual amount of vehicles being in the motion. This is although less important with the increasing of the congestion level, when the network is overloaded up to critical values. The difference between standing in a traffic jam involving 1000 or 1100 vehicles is less noticeable than the difference between standing in a traffic jam involving 10 or 100 vehicles.

The analysis of regression residuals of the lines of the best adjustments for variable defined as a number of places in vehicles of the commuters is needed for proper stochastic modelling of the volume and the road congestion. This modelling was performed for various scenarios of the population flows in transport corridors of Poznan agglomeration.

The research of the influence of the introduction of proposed project of suburban trains and additional incentive instruments (or disincentive ones) for the individual commuting by cars was made by the help of the survey. The volume of these flows was modelled for six various scenarios:

- basic – introduction only the suburban trains, without additional instruments for the regulation of the flows,
- MBS – combination optimizing the most effective instruments for the regulation of the flows, without the system of charges connected with congestion and the increase of parking charges in the city area,
- MBS* - combination optimizing the most effective instruments for the regulation of the flows, including the system of charges connected with the congestion and the increase of parking charges in the city area,
- introduction of the congestion charges – option of the introduction of the congestion charges for city area of Poznan during weekdays,
- increase of the parking charges – the option of the increase of the parking charges in city area of Poznan,
- simultaneous introduction of congestion charges and the increase of parking charges - simultaneous introduction of congestion charges in weekdays and the increase of parking charges in city area of Poznan.

The hourly distributions of the flows obtained from the researches were compared to the current situation, e.g. without a more efficient use of the existing railway infrastructure. The results confirmed the assumptions, that only the introduction of the new project of suburban trains (basis scenario) has a great influence on the reduction of the morning peak by approximately 1100 (32%), 1600 (38%) and 2600 (59%) rides per hour along respectively: northern, eastern and southern transport corridor. The greatest scepticism to the introduction of such a solution was recorded among the inhabitants, using the northern corridor. The users of the eastern corridor showed more enthusiasm about it, but the greatest interest was observed along the southern corridor. In this case, the people, having the modern and fast railway transport, were more likely to use the alternative solution instead of using their own cars. The commuting by the use of railway is already at present realised along the southern corridor more often than in eastern and northern corridor, and probably it is the reason of the obtained results.

The analysis of the scenarios including additional instruments regulating the flows (as accelerators or inhibitors) showed that the best results were obtained by the use of the scenarios MBS and MBS* - the combinations reducing the modelled level of the use of individual cars as the mean of commuting to the level below 20 or even 10% of the initial volume. The smallest volume of commuting travels in these scenarios was recorded in the northern corridor, where the additional instruments regulating the commuting flows would probably find the best adjustment to the preferences among commuters, using their cars. On the other side, the biggest flows would remain in the eastern corridor, confirming the big preferences of those inhabitants to use their own cars. The confidence interval in these researches is between 10-12% and therefore the differences between the results of MBS and MBS* scenarios are

not significant. It means, the solutions such as congestion charges and changes in parking charges could be replaced by local instruments regulating the flows, e.g. buffer parking around the railway stations (so called park-and-ride ones).

On the other hand, the influence of congestion charges and the increase of parking charges within the city area as the instruments of commuting policy were identified as a significant one. However, this effect is various in the various examined corridors, the smallest impact was observed in the southern corridor, when the introduction only of the additional trains was a sufficient incentive to resign from own cars. The obtained results are less promising in other corridors, where the bigger preferences to use own cars were recorded. Summary – the congestion charges have the stronger influence on the reduction of usage of the own car than the parking charges. Therefore, it is not surprising, that the combination of these two solutions is of the synergistic nature and so-called final result of their introduction is biggest than the simple sum of them. It should be noted however, that this increases in not significant, due to the fact, that it concerns the same group of the population. The obtained results show that the inhabitants prefer to use their own cars despite the congestion charges and the parking charges within the city zone and therefore other instruments should be applied.

The introduction of the suburban trains, especially associated with the introduction of the other instruments regulating the flow (based on the system encouraging the desirable behaviours and discouraging the undesirable behaviours), shows the high potential for the possible reduction of the commuting rides performed by cars. However, the influence of this solution on the traffic level and the congestion is of the highest importance in the estimation of its usefulness.

Two lines of the best adjustments from the regression analysis (table 1) were obtained during this research. The formula, obtained as its result and describing the relative delay rate as well as total road flow as a function of the volume of commuters using their cars, were considered statistically poorly explained for forecasting purposes (in first case – high values p, in second case – low value of the coefficient R^2). Therefore, the evaluation of the effectiveness of this project to reduce the road congestion is based on the changes of the average speed of the vehicle.

The obtained results (comparing to initial conditions along the northern corridors and after the introduction of expected scenarios) show, that the midday and all-day traffic will be significantly reduced (even after the introduction of the basic scenario only). It would lead to the higher speed of the vehicle, practically similar to the speed in the congestion-free conditions (small differences ±10km/h are negligible, due to the size of the confidence interval and the value of the standard deviation S).

The greater variability of the traffic volume is observed during the morning peak, which indicates its greater dependence in relation to the proposed introduction of suburban trains. The congestion charges and the increase of the parking charges in the city area of Poznan, would reduce the level of the road traffic – but not as efficiently as MBS and MBS* scenarios. The interesting results can be observed during the analysis of the basic scenario – the level of the road traffic is higher after the introduction of the project of suburban trains in comparison to situation before this introduction. The limited accuracy of the model function obtained from the regression analysis is the reason of this and therefore it should not be taken for the forecasting. The situation in the eastern corridor is similar to the situation in the northern corridor. The mere introduction of suburban trains reduces the volume of individual cars to the level of 400 per hour during the day and in the afternoon peaks, which enable to obtain the speed of the car close to the values characteristic for the traffic in free conditions – limited only by the valid traffic regulations (with the confidence interval 10,03% and at the confidence level 95%). The reduction of the amount of individual cars would be associated with the increase of the average speed of the car also during the morning peaks. The scenarios MBS and MBS* turn out to be once again the most effective ones. The differences between their influence and the introduction of the congestion charges and the increase of the parking charges are not so significant as in the case of the northern corridor. The habits of people to use their own cars as well as some facilities related to this, e.g. possibility to use the highway – can be the reason of this. The final effect of the introduction of suburban trains along the eastern corridor manifested in higher speed of all passengers and the reduction of the road congestion. The reduction of the flows along the southern corridor was not so high during the day and in the afternoon peaks (with the confidence interval 10,87% and at the

confidence level 95%). However the expected increase of the average speed of the car in these periods of the time is more significant, which could suggest, that the road congestion in this corridor is not caused by the individual cars, but rather by other vehicles involved in the traffic of this corridor.

Table 1. Formulas obtained and used to model the passenger traffic and the average speed of the car
Tabela 1. Formuły uzyskane i używane do modelowania ruchu pasażerskiego oraz średniej prędkości przejazdu

Variable (x)	**Variable (y)**	**Line of the best adjustment**	**S**	**R^2**	***p***	***p* const**
CCV	PTV	$y = 421 + 0.193x$	348	51.0%	0.009	0.007
Ln(CCV)	AS	$y = 86.1 – 5\ .60x$	9.18	44.6%	0.018	0.001

Remarks: Amount of surveys: 3200
- *CCV – amount of places in vehicles of commuters*
- *PTV – volume of the passenger road traffic*
- *AS – average speed of the car*

Source: own calculations base on date obtained from Municipal Roads Management in Poznan and own surveys

In the case of the morning peaks, the mere introduction of suburban trains reduces the number of individual cars up to the situation, where the additional instruments regulating the flows are not necessary. It is the result of the more positive attitude of inhabitants using the southern corridor to the train transport and therefore there is no need to use the additional instruments, based on the system, which encourages the desirable behaviours and discourages the undesirable behaviours in this regard.

Following this study, the commuting passenger transport was stated to play the key role within the whole area of the agglomeration of Poznan. The most of the inhabitants would not be able to reach their workplaces, schools and services without the proper functioning of this transport, and it could disturb the integration and the competiveness of the whole metropolitan area [Broll 2004]. The examined dynamics of population flows indicates that the commuting rides based on individual cars are the basis of all passengers' flows occurring between suburban areas and Poznan. The central part of the city is the most intensively used one for this purpose. It means, that thousands of cars enter every day this area, limited spatially, and additionally reduce its throughput. It means that these shuttle flows seriously influence the functioning of the transport system of the city as a whole. It is also the confirmation of a well-known rule of internal relationships of the metropolis, which manifests not only in the influence of the city on the surroundings but also vice-versa, at least at an equivalent level. Therefore, the efficient and effectively functioning system of the public transport seems to be indispensable to achieve the long-term competitiveness and the viability of the whole agglomeration area.

Although, the cyclic fluctuations of the flows were observed along all transport corridors, there are big differences in their volumes, directions, scheduling and the types of used means of the transport. The morning and afternoon peaks of passenger flows are characteristic for all corridors and are equal to the maximal value of the volume of the road traffic. It is also the confirmation of a well-know theoretical relationship between the suburbanization and the increase of the road traffic [Rodrigue 2006].

However, the results obtained from the researches not always confirm this statement. It turn out, that the biggest delays were recorded along the northern corridor, being the least urbanized one and of the lowest density of the population. The underdevelopment of the communication infrastructure and practically no alternative connections (detours, shortcuts) seems to be the critical factors in this case. This situation is consistent with other situations observed in 80's of the last century in many cities of the West. Consequently, it was the significant impulse to create modern and efficient transport systems. However, the researches of schedules of the flows, in the connection with the average speed of the car and the relative delay ratio revealed an additional factor, causing the congestion in the northern corridor – the limitation of time of the peaks of the cars' concentration only to two hours – in comparison to four hours in other corridors. Unfortunately, the reason of such situation cannot be fully explained using the conducted researches and can be a good reason for further investigations.

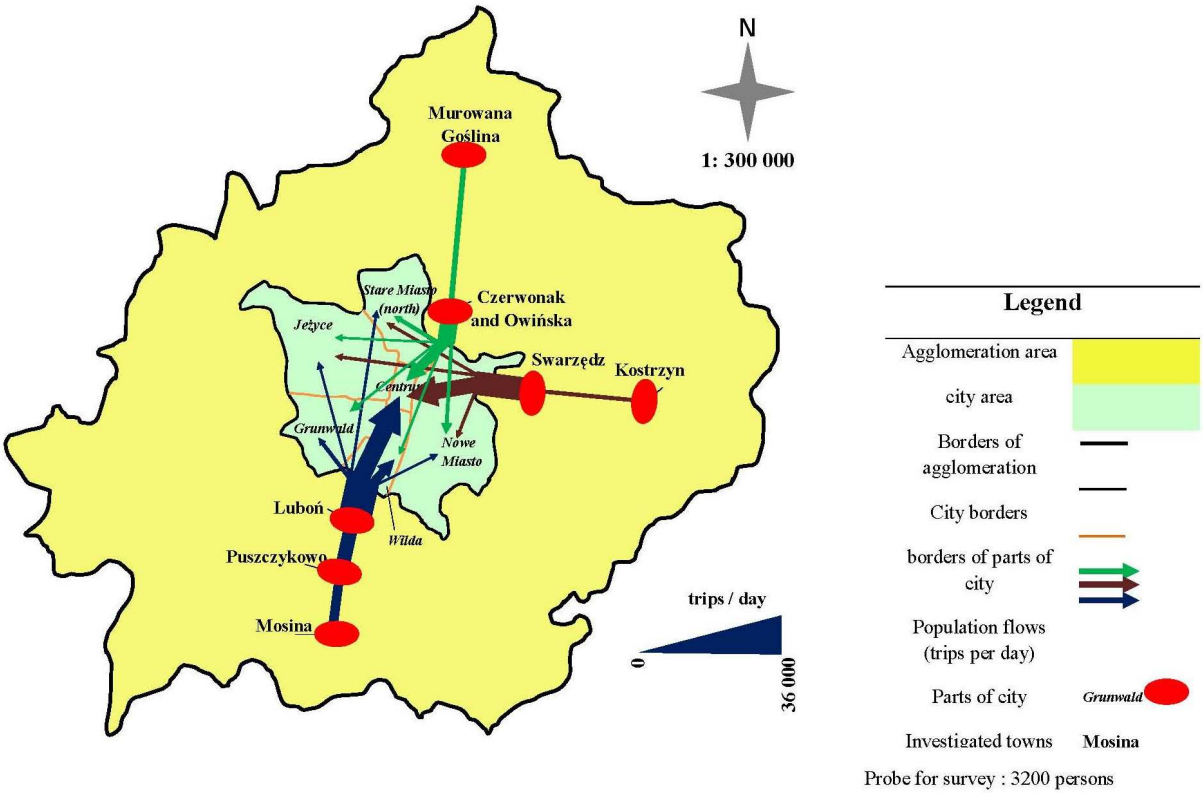
The similar researches conducted in other countries proved that the continuous communication problems express themselves very often in the lack of residential satisfaction of the inhabitants [Broll 2004]. It was also officially confirmed in surveys, conducted by the author among the inhabitants of the areas along the northern corridor (Czerwonak, Murowana Goślina). They experience the biggest delays, which cause the biggest dissatisfaction of the conditions of the road traffic among them comparing to the inhabitants surveyed along the other transport corridors. On the other hand, the most satisfied with the current situation is not the group which has an access to the highway (along the eastern corridor), but this one, which has an access to many alternative possibilities of the public transport (buses and to some extend trains). It confirms the rule, that the diversity of the communication routes and the convenient public transport can effectively replaces the highways to reduce the delays due to the congestion.

As it was already stated, the investigated events concern very complicated and dynamic urban area. However, thanks to conducted investigating procedure, a quite important insight and the identification of the way of the functioning of this urban organism were allowed. The strong connections between the total traffic level and the level of passenger flows show, that the increased congestion in peak hours is caused mainly by individual cars and not by the lorries and buses. Additionally it was found, that the daily flows of the population are strongly positively correlated with the changes of the volume of the commuters. The form of the relation between the speed of passenger flows (the average speed of a car) and the volume of road traffic seems to be very interesting from the point of view of the road traffic engineering. The logarithmic nature of these relationships was found, i.e. the speed of the travel drops more rapidly for the smaller volume of the road traffic and commuters than for the bigger values of this volume. It means that the traffic congestion causes some kind of the blockade of the further rapid decreasing of the flow speed. These relationships taken jointly indicate, the commuting of the population in the metropolitan area of Poznan contributes greatly to the formation of the road congestion, like in other large urban areas, such as Barcelona [Asensio 2002] or Tallinn [Tammaru 2004]. Therefore, the purposefulness of activities should be recognised in the promotion of local job markets, which reduces directly the necessity of the commuting [Domański 2006] as well as to shift the greater part of the individual commuting to the public transport system. It can lead to the reduction of the flows and therefore to the reduction of the road congestion.

A significant role of the public transport in the process of the improving of the effectiveness of population flows was already taken as an axiom, both by scientists and by politicians and business. It is also confirmed by the results of conducted researches, that the better usage of the existing infrastructure of suburban railways could undoubtedly reduce the flows realised by the use of the individual cars and therefore reduce the congestion level. However, the range of this reduction depends on the area, where it would be introduced and additional instruments regulating the flows (based on the system encouraging desirable behaviours and discouraging undesirable behaviours). It is interesting to point out; that the biggest enthusiasm to introduce the suburban trains was recorded among the inhabitants of the area, where the system of suburban trains already functions, providing the alternative to the commuting transport. It suggests that the test variant should be introduced before the full-scale implementation of new solutions. In this way, both inhabitants and the authorities could estimate the advantages and disadvantages of a new solution. Furthermore, the effectiveness of the instruments regulating the flows and introduced as a part of the transport policy (congestion fees, the increase of parking fees in the city area) will be probably confirmed in the practise, especially in the eastern corridor of the metropolitan area of Poznan, where the inhabitants show the strong habits to use their own cars in transport flows. It should be pointed out, that the introduction of such instruments on the city scale could be quite expensive and therefore it would undoubtedly cause the discussion on the purposefulness of these actions as well as some kind of inequality of the inhabitants. The solutions of these types could be certainly successful on the local scale – to encourage the inhabitants for combined travels – the connection of the railway public transport together with free buses to the railway station or a buffer parking of a park-and-ride type. It should be noticed, that the adaptation of the existing railway infrastructure could significantly reduce the costs of this project and help to create truly integrated transport system, not only the passengers' one but also the goods' one.

The means of the public transport are regarded as more economical and social effective ones. However, the disadvantages of these types of solutions are noticed as well. For example, the people

living close to the railroads are exposed to the increased doses of the noise and vibrations. Furthermore, at least a part of the population by the resigning of the use of their own cars could suffer some kind of a discomfort to use the public transport. The instruments regulating the flows and based on the system to encourage the desirable behaviour and discourage the undesirable behaviour are also sometimes critized. The open questions are still: Why should the authorities provide the free buses? Why should they provide the land for the buffer parking and thereby promoting the commuting to Poznan instead of concentrating on the local business, which could create workplaces near the residence of the population? There is also the problem of the correct forecasting of future scenarios of the spatial development of the whole agglomeration area. Will such a solution be needed and what kind of the technical support for it will be necessary? It seems that only the technical and financial aspects of such project require further separate studies. However, it is out of the aim of this study, which was concentrated on the task to investigate, whether the project of suburban trains using the existing railway infrastructure in the agglomeration of Poznan, can influence the reduction of the congestion level. The results seem to provide the promising prospects to improve the transport conditions in the whole agglomeration of Poznan. In a broader context, the study showed, that Polish cities can also develop their transport systems in more sustainable way by the better use of the existing railway infrastructure, despite of the marginalizing its utilitarian value in the last years, especially at the end of the twentieth century. At present, these aspects should be regarded as the opportunity to create the modern public transport system for inhabitants of agglomerations, which are exposed to the growing problem of the congestion.



Source: own work based on the surveys

Fig. 2. The spacial distribution of the population flows from selected locations to Poznan metropolitan area
Rys. 2. Rozkład przestrzenny przepływów ludności z wybranych miejscowości obszaru metropolitalnego do Poznania

CONCLUSIONS

The procedures and research methods applied to conduct this study are also used in various disciplines – from the geography of the transport, through the city logistics up to traffic engineering and economic sciences. Such a combination of research instruments were necessary to determine, whether the optimization of the dynamics of the population flows in transport corridors of the metropolitan area of Poznan can lead to the reduction of the road congestion by the better use of the existing railway infrastructure. The results obtained in multi-methods analysis showed, that such solution is likely to be a successful one as an alternative to the road transport. At present, the dominant form of the commuting travels is the individual transport by cars, which daily shuttle trips are connected with flows between suburban municipalities and Poznan. The centre of the city is the main target for these people. The reduction of commuting trips performed by cars could have a positive impact on the improving of the traffic conditions in the central part of the city. At present, the high level of the road congestion is observed both in the centre of the city as well as in transport corridors, especially during the morning and afternoon peak hours. It is probably the reason, why most of the inhabitants are not satisfied with the commuting conditions, characterized by significant delays and the slow speed of the movement. It seems to be ironic, that the same people are the main reason of the increasing road congestion along the transport corridors by their habits and behaviours. The reduced speed of the travel and big traffic jams during morning and afternoon peak hours are the main evidences of these occurrences. In other words, the congestion problem caused by the commuting is present in investigated area and is the main reason of the reducing of transport efficiency realized in the whole agglomeration. Can the introduction of suburban railway transport improve the situation?

The modelling conducted in the research process of this study and based on the regression analysis and survey data clearly showed that, the introduction of such a solution could reduce the road congestion, especially when the system encouraging the desirable behaviours and discouraging the undesirable behaviours will be included in this project. The solutions covering the whole area of the city, such as the introduction of congestion charges and increasing the parking charges would certainly increase the economical effectiveness of such solutions (the majority of the commuters would choose the trains), but taking into the consideration the social aspects in the wider range, the combinations of the local solutions, such as free parking places and the increased frequency of trains seem to be able to be even a greater success. The combinations of such solutions were derived in the studies based on the survey data and optimization algorithm (MBS). It means, the strategies and solutions designed in accordance with articulated preferences of the population, may be more effective than large-scale initiatives issued by a superior. This aspect seems to be often not taken into the consideration by the politicians and decision-makers and often plays a significant role in the process of designing of efficient transport systems.

The conclusion raised on the basis on this study is, that railway transport system can significantly reduce the level of the road congestion and thus improve the efficiency of the entire system of the urban transport. Furthermore it was demonstrated, that the "difficult" heritage of the poorly used or unused railway infrastructure, occurring in many urban areas, could be often successfully adapted to be a modern solution for the transportation needs of the inhabitants. It is particularly important in the context of the political past of Polish cities, which experience the big increase of the congestion in the last years. The financial resources of these cities to solve these problems are restricted, while often they have infrastructures weakly used and being the remnants of old conditions and relationships of social and economic development.

There is still a question to be considered, whether a similar solution could improves the effectiveness of the management of population flows also in other European and world metropolitan areas. The dynamics and complicated character of transport systems and the possible significant influence of other factors, such as changing preferences and behaviors of inhabitants, the type of the infrastructure or even a cultural environment, mean that the usability of the similar project in other geographical areas is uncertain. The true reactions and subsequent behaviors of the inhabitants are the most uncertain factor also in case of Poznan. It is not clear, that the inhabitants will act in the same way, as they declared in the survey and which is the background of the success of this project. The one

conclusion is certain, without the confrontation and the combating of the congestion; the transport system of the cities will be blocked and will have negative consequences of economical, environmental and mainly social nature.

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DYNAMIKA PRZEPŁYWÓW LUDNOŚCI OBSZARÓW METROPOLITALNYCH

STRESZCZENIE. W artykule przedstawiono analizę dynamiki przepływów ludności w korytarzach transportowych obszaru metropolitalnego, na przykładzie Poznania. Wykonane badania miały na celu określenie mobilnych preferencji ludności a także możliwości polepszenia efektywności działania transportu miejskiego, głównie w aspektach związanych i prowadzących do zmniejszenia kongestii drogowej - przy pomocy lepszego wykorzystania istniejącej infrastruktury kolejowej obszaru a także innych instrumentów polityki transportowej. Uzyskane poprzez analizę multimetodyczną rezultaty wykazały, że takie rozwiązanie ma szansę odnieść sukces jako alternatywa dla transportu drogowego a różne strategie i rozwiązania zaprojektowane zgodnie z wyartykułowanymi preferencjami ludności, mogą być bardziej efektywne, niż wielkoskalowe inicjatywy o charakterze odgórnym. Występujące często w wielu obszarach zurbanizowanych "trudne" dziedzictwo słabo lub wcale niewykorzystywanej infrastruktury transportu kolejowego, może zostać niejednokrotnie z pełnym powodzeniem zaadaptowane dla rozwiązania potrzeb transportowych ludności.

Słowa kluczowe: obszar metropolitalny, zarządzanie miastem, kongestia, transport pasażerski, logistyka miejska, dojazdy do pracy, przepływy ludności.

DYNAMIK DER BEVÖLKERUNGSSTRÖME IN METROPOLITANEN BALLUNGSGEBIETEN

ZUSAMMENFASSUNG. Der Artikel präsentiert eine Analyse der Dynamik der Bevölkerungsströme in den Transportkorridoren eines Stadtgebiets, am Beispiel der Stadt Poznan. Das Ziel dieser Studien war es, die mobilen Präferenzen der Bevölkerung sowie die Möglichkeiten zur Verbesserung der Effizienz des Stadtverkehrs zu bestimmen, vor allem in solchen Aspekten wie die Überlastung der Straßen und deren Reduzierung durch eine bessere Nutzung der vorhandenen Schieneninfrastruktur sowie andere Instrumente der Verkehrspolitik. Die Ergebnisse einer Multi-Methoden Analyse zeigten, dass eine solche Lösung eine erfolgreiche Alternative zum Straßenverkehr darstellen könnte und die verschiedenen, den artikulierten Präferenzen der Bevölkerung zufolge geplanten Strategien und Lösungen viel mehr als großgeskalte, höheren Orts aufgezwungene Initiativen wirksam werden können. Das oft in vielen städtischen Gebieten vorkommende, "schwierige" Erbgut von wenig oder gar ungenutzter Eisenbahn-Infrastruktur kann oft für die Lösung der Transportbedürfnisse der Bevölkerung erfolgreich adaptiert oder angewendet werden.

Codewörter: Metropolitanes Ballungsgebiet, Stadtverwaltung, Verkehrsüberlastung, Personenverkehr, Stadtlogistik, Transport, Pendeln, Bevölkerungsströme.

Zbyszko Pawlak
Wyższa Szkoła Logistyki
ul. Estkowskiego 6
61-755 Poznań, Polska
e-mail: zbyszko.pawlak@wsl.com.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 2
No 2

http://www.logforum.net

SUPERVISOR'S ROLE IN TRAINING PROGRAMS AS A MANAGER OF LEARNING PROGRAM

Muhammad Madi Bin Abdullah[1], Mas Bambang Baroto[1], Azman Ismail[2], Huam Hon Tat[1]

1) University Technology Malaysia, 2) National Defence University of Malaysia, Kuala Lumpur, Malaysia

ABSTRACT. According to the training literature, a supervisor's role in training programs has two major elements: supervisor support and supervisor communication. The ability of supervisors to play effective roles in training programs may increase employees' motivation to learn. The nature of this relationship is interesting, but the role of supervisor's role as a predicting variable is less emphasized in a training program models. Therefore, this study was conducted to examine the effect of supervisor's role in training programs on motivation to learn using 152 usable questionnaires gathered from non-academic employees who have worked in a technological based public university, Malaysia. The outcomes of stepwise regression analysis showed that the supervisor support and supervisor communication significantly associated with motivation to learn. Statistically, this result demonstrates that supervisor's role in training programs does act as an important predictor of motivation to learn in the organizational sample. In addition, discussion, implication and conclusion are elaborated.

Key words: supervisor's role in training programs, motivation to learn, Malaysia.

INTRODUCTION

Supervisors are considered as the first level of management who are given major duties and responsibilities to lead work groups in organizations [Goldstein, Ford 2002, Noe 2010]. In the administration of training programs, supervisors usually refer to the management team and experienced employees to ensure that the implementation of training activities will achieve the set objectives [Yamnill, McLean 2001, DeSimone et al. 2002]. Their role is often seen as a critical training climate factor that may support or resist employees to enter, participate and learn necessary knowledge, up to date skills, new abilities and positive attitudes in training programs [Blanchard, Thacker 2007, Noe 2010]. Interestingly, extant research in training climate reveals that the ability of supervisors to provide adequate support and use comfortable communication about training programs may lead to an increased employees' motivation to learn in organizations [Baldwin, Magjuka 1991, McGraw 1993].

Although the nature of this relationship is interesting, not much information has explained about the role of supervisor's role as an important predicting variable in training program research literature [Chiaburu and Takleab 2005, Tai 2006]. Many scholars argue that the role of supervisor's role as a predicting variable is given less emphasized in previous studies because they has much described supervisor role characteristics and given little attention on how and why the characteristics of

Citation: Muhammad Madi Bin Abdullah et al., 2011, Supervisor's role in traning programs as a manager of learning program. LogForum 7, 2, 2
URL: http://www.logforum.net/vol7/issue2/no2
Accepted: 11.04.2011, on-line: 5.05.2011.

supervisor's role influencing motivation to learn in the workplace training program models. As a result, findings of such studies have not provided sufficient evidence to be used as guidelines by practitioners in designing appropriate strategies for improving the effectiveness of staff training and development program in an era of global competition [Tsai, Tai, 2003, Blanchard, Thacker 2007]. Hence, it motivates the researchers to further explore this relationship. The aim of this paper is to examine: (i) the link between supervisor support and motivation to learn, and (ii) the link between supervisor communication and motivation to learn.

LITERATURE REVIEW

Explanation of the constructs

This study highlights two important constructs, namely supervisor's role and motivation to learn. According to human resource management scholars like Facteau et al. [1995], Chiaburu and Takleab [2005] and Ismail et al. [2010] state that supervisor's role has two major features: supervisor support and supervisor communication Firstly, supervisor support is often related to a supervisor who provides encouragement and opportunities to improve employee performance in organizations [Goldstein, Ford 2002, Noe 2010]. Secondly, supervisor communication is often viewed as the activity or process of expressing ideas or feelings while giving people information, as well as exchanging ideas and information between a person or a group through symbols, actions, written or spoken words in order to impart information and ideas effectively [Lumsden, Lumsden 1993, Harris et al. 2000]. Besides that, many organizational behaviour scholars, such as Knowles [1989], Blanchard, Thacker [2007] and Noe [2010] state that the motivation to learn consists of two major components: motivation and learning. Motivation is often defined as direction, persistence and amount of effort that may be expanded by an individual to achieve his/her particular objective. Learning is usually viewed from the human, cognitive and behaviour perspectives. In a training program model, many scholars view that supervisor support, supervisor communication and motivation to learn are different constructs, but highly interrelated.

Theoretical and empirical evidence between the supervisor's role and motivation

This study is consistent with the notion of motivation to learn theories. First, Locke and Latham's [1990] goal setting theory postulates that goals direct individuals to perform a task. The application of this theory in training programs shows that the ability of a supervisor to encourage employees learning a proper technique and providing clear explanations about the procedures of attaining the goals will strongly increase employees' motivation to learn [Brown et al. 2001, Goldstein, Ford 2002]. Second, Adams' [1965] equity theory states that fair or unfair treatment has a significant impact on individual's attitude and behaviour. The application of this theory in training management shows that employees who receive sufficient support from their supervisors while applying and attending training programs will perceive equity. In this regard, if individuals feel that they are fairly treated and supported by their supervisors, this will subsequently invoke their motivation to learn. [Mathieu et al. 1992, Chiaburu, Takleab 2005]. Finally, Vrooms' [1973] expectancy theory highlights that an individual will perform certain actions if he/she perceives such actions may bring valued outcomes. Its application shows that the ability of a supervisor to openly and honestly communicate the value of attending training programs and its importance of learning new competencies will strongly increase employees' motivation to learn.

Several studies have shown the positive effect of supervisor's role in training programs on motivation to learn. For example, several studies about supervisor's role in training programs based on a sample of 45 trainees in UK organizations [Axtell, Maitlis 1997], and 100 technical employees in North Kuching City Hall, Malaysia [Ismail et al. 2008] generally showed that properly implemented supervisor's role in training programs had invoked employees' motivation to learn up to date knowledge and skills. Specifically, two surveys about supervisor communication in training programs

were carried out based on a sample of 126 employees in Northern Taiwan [Tai 2006], and 100 technical employees in North Kuching City Hall, Malaysia [Ismail et al. 2007]. Meanwhile, three surveys about supervisor support in training programs were conducted based on a sample of 179 trainees and 32 supervisors at certain US organizations [Nijman 2004], 119 employees who attended training program in a large organization in USA [Chiaburu, Takleab 2005], and 100 technical employees in North Kuching City Hall, Malaysia [Ismail et al. 2007]. Their findings advocate that the willingness of supervisors to provide better explanations about the training plans and the ability of supervisors to properly provide training supports had invoked employees' motivation to learn.

Conceptual framework and research hypothesis

The literature has been used as foundation to develop a conceptual framework for this study as shown in Figure 1.

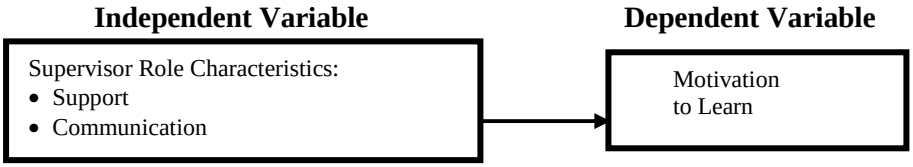

Fig. 1. Conceptual framework
Rys. 1. Ramy teoretyczne

Based on the framework, it seems reasonable to assume that the ability of supervisors to play proper roles in training programs will affect Malaysian public university employees as this has influenced overseas employees. Motivation to learn theories further suggest that the ability of supervisors to provide sufficient support and practice comfortable communication will strongly motivate employees to learn necessary knowledge, new skills and positive attitudes in training programs. Therefore, it can be hypothesized that:

H1: There is a positive relationship between supervisor support and motivation to learn

H2: There is a positive relationship between supervisor communication and motivation to learn

METHODOLOGY

Research design

This study used a cross-sectional research design, which allowed the researchers to integrate training management literature, the in-depth interview, the pilot study and the actual survey as a main procedure to gather data for this study. At the initial stage of this study, in-depth interviews were conducted before and during the pilot study. Before conducting the pilot study, an in-depth interview was conducted involving two experienced supporting administrative staff. Then during the pilot study, another in-depth interview was done involving an assistant human resource manager, head of Training Unit, and eight experienced supporting staff who work in the organization. They are selected based on purposive sampling where the employees have good knowledge and experience about the design and administration of training programs. Information gathered from such employees helped the researchers to understand the nature of supervisor's role, motivation to learn characteristics, job performance features, as well as the relationship between such variables in the target organization. After transcribing, categorizing and comparing the information with relevant theoretical and empirical evidence, the triangulated outcomes were used as a guideline to develop the content of the survey

questionnaire for the pilot study. Next, a session was initiated for discussing the items in survey questionnaire with the above participants in order to verify the content and format of the questionnaire for the actual study. The back translation technique was used to translate the survey questionnaires in Malay and English and this may increase the validity and reliability of the instrument [Van Maanen 1983, Wright 1996].

Measures

The survey questionnaire consisted of four sections. Firstly, demographic information had 9 items. Second, supervisor support had 17 items that were derived from the training research literature [Chiaburu, Takleab 2005, Ismail et al. 2007]. Thirdly, supervisor communication had 13 items that were derived from the transfer of training literature [Yamnill, McLean 2001; Ismail et al. 2007]. Fourthly, motivation to learn had 12 items that were based on the training program literature [Noe 2010, Rodríguez, Gregory 2005]. All the items used in the questionnaire were measured using a 7-item scale ranging from 'strongly disagree' (1) to 'strongly agree' (7). Demographic variables were used as the controlling variable because this study also focused on employees' attitude.

Unit of analysis and Sampling

The targeted population for this study was 574 non-academic employees who have worked in a Malaysian public university. After considering the organizational rules, a convenience sampling technique was used to distribute the questionnaire to all 574 employees who willing to participate through the Human Resource office. Of the number, 152 usable copies of the questionnaire were returned to the researchers, yielding a response rate of 26.4 percent. The survey questions were answered by participants based on their consent and voluntary basis. The number of this sample exceeds the minimum sample of 30 participants as required by probability sampling technique, showing that it may be analyzed using inferential statistics [Leedy, Ormrod 2005, Sekaran 2008].

RESULTS AND DISCUSSION

The demographic profile of the respondents is as follows: The most respondent characteristics were male (65.1%), aged ranging from 20 to 39 years old (37.5%), MCE/SPM holders (56.6%), length of service with less than 6 years (48.7%), training attended in own organization (46.7%), and those who had learning experience in technical field, management field and administrative field (34.2%). The results of validity show that three factors were extracted, which were related to the three tested variables: supervisor support (3 items), supervisor communication (5 items), and motivation to learn (4 items). Relying on Hair et al. [2010] guidelines, these statistical analyses showed that: (1) all variables exceeded the acceptable standard of Kaiser-Meyer-Olkin's value of 0.6, (2) all variables were significant in Bartlett's test of sphericity, (3) all variables had eigenvalues larger than 1, and (4) the items for each variable exceeded factor loadings of 0.50 [Hair et al. 2010]. All research variables were also found exceeded the acceptable standard of reliability analysis of 0.70 [Nunally, Bernstein 1994]. As a whole, these results confirm that the measurement scales met the acceptable standard of validity and reliability.

Table 1 shows the results of Pearson correlation analysis and descriptive statistics. The mean values for the variables are from 3.3 to 4.0, signifying that the levels of supervisor's support, supervisor communication, and motivation to learn ranging from moderately high (3) to highest level (7). The correlation coefficients for the relationship between the independent variables (supervisor support and supervisor communication) and the dependent variable (motivation to learn) were less than 0.90, indicating that the data were not affected by serious collinearity problem [Hair et al. 2010]. An examination of multicollinearity in the coefficients table shows that the tolerance value for the relationship between the independent variables (i.e. supervisor support and supervisor communication) and the dependent variable (i.e. motivation to learn) was 0.51, and 0.41, respectively. These tolerance

values were more than the established tolerance value of 0.20 (as a rule of thumb), indicating the variables were not affected by multicollinearity problems [Fox 1991, Tabachnick et al. 2007].

Table 1. Pearson correlation analysis and descriptive statistics
Tabela 1. Analiza korelacji Pearsona i statystyki opisowe

Variable	Mean	Standard Deviation	Pearson Correlation Analysis		
			1	2	3
1. Supervisor Support	3.3	0.42	1		
2. Supervisor Communication	3.7	0.37	.51**	1	
3. Motivation to Learn	4.0	0.41	.45**	.41**	1

Note: Significant at p*<0.05;**p<0.01

To better understand the relationship between the two supervisory elements and motivation to learn, a-two predictors multiple regression linear regression (MLR) model was proposed. The two-predictor variables are supervisor support (X_1) and supervisor communication (X_2). Based on the stepwise method used, all the two-predictor variables were found to be of significance in explaining motivation to learn. As depicted in Table 3, the estimated model is as in the following equation: Y (MTL) = $1.556 + 0.510X_1 + 0.410X_2 + e$. The R^2-squared of 0.433 implies that the two predictor variables explain about 43.3 percent of the variance/variation in the motivation learn. This indicates that the supervisor support and supervisor communication act as important predictor of motivation to learn in the organizational sample.

Table 2. Estimates of coefficients for the regression model
Tabela 2. Oszacowanie współczynników dla modelu regresji

	B **(unstandardized Coefficients)**	**Std error**	**Beta (standardized Coefficients)**	***t***	***p*-value**
Constant	1.556	0.152		13.136	0.0001
Supervisor Support	0.510	0.037	0.554	6.105	0.0001
Supervisor Communication	0.410	0.028	0.436	4.354	0.0001

Notes: R= 0.658; R^2= 0.433; Adj. R^2= 0.430

Specifically, Table 3 shows that the largest beta coefficient (0.510) for supervisor support. This means that this variable makes the strongest unique contribution to explaining the dependent variable (motivation to learn), when the variance explained by the other predictor variable in the model is controlled for. The Beta value of supervisor communication is the second highest (0.410). Thus, H1 and H2 that relates the two supervisor role characteristics with motivation to learn are fully supported. Therefore, it can be argued that the two supervisory elements are directly involved in improvements in employee motivation to learn. This also suggests that the greater the extent to which these two elements are present, the greater will be the motivation to learn among the employees. Moreover, the findings also indicate that the most important supervisory element for motivation to learn is supervisor support (b= 0.510), which was significant at the 0.0001 ($p < 0.05$) levels.

The implications of this study can be divided into three major aspects: theoretical contribution, robustness of research methodology, and contribution to practitioners. In term of theoretical contribution, the findings of this study show that the ability of supervisors to implement adequate support and comfortable communication style has increased employees' motivation to learn in the studied organization. This result has supported and broadened training research literature mostly published in western countries [Axtell, Maitlis 1997, Baldwin, Magjuka 1991, McGraw 1993,

Chiaburu, Takleab 2005]. With respect to the robustness of the research methodology, the survey questionnaire used in this study had met the acceptable standards of validity and reliability analyses. Hence, this could lead to the production of accurate and reliable findings.

Regarding practical contributions, the findings of this study can be used as a guideline by human resource managers to improve the efficiency and effectiveness of training programs in government of owned universities. This objective may be achieved if management implements several important suggestions: firstly, customize training contents and methods according to university needs and expectations. For example, the content of training programs for management employees should impart advanced human skills that may help them to understand individuals' cognitive, emotion and psychomotor. Management employees will feel ease to apply such training contents if professional trainers are hired to guide management employees in implementing interpersonal communication skills, managing change and conflict, as well as practising problem solving techniques in the workplace. Secondly, allow supervisors to be involved in higher-level training committees so that they may clarify the needs and expectations of majority employees at the grass root level. Information gathered from such employees may be used to establish appropriate training modules that can support organizational and human resource management's strategies and goals. Thirdly, change in the university human resource policies from hiring employees based on conforming to organization policies and procedures to hiring employees based on creativity and innovations. This new hiring perspective will help university management to hire employees who possess higher levels of knowledge, experience and competencies. Their capabilities can be used to train operational employees in terms of attitude and working styles, as well as to handle employees' demands with better treatment like showing more respect, be honest and accountable. Finally, improve the type, level and/or amount of compensation and benefits program for supervisors based on current market needs in order to motivate them to accomplish organizational strategy and goals.

The outcomes of stepwise regression analysis confirmed that supervisor's role (i.e. supervisor support and supervisor communication) significantly associated with motivation to learn, which fully explains that the ability of supervisors to properly adequate support and use comfortable communication may increase employees' motivation to learn necessary knowledge, up to date skills, new abilities and positive attitudes in training programs. This finding is consistent with organizational training research literature mostly published in Western organizational settings. Therefore, current research and practice within training management models needs to consider supervisor support and supervisor communication as a vital aspect of the organizational training system where it could increase individuals' motivation to learn in training programs. Hence, these positive outcomes may lead employees to sustain and achieve organisational competitiveness in an era of global competition.

LIMITATIONS AND FUTURE RESEARCH

The results of this study should consider the following limitations. Firstly, the data was only taken once during the duration of this study. Therefore, it did not capture the developmental issues such as intra-individual change and restrictions of making inference to participants and/or causal connections between variables of interest. Secondly, this study only focused on particular elements of a supervisor's role and neglected other important factors (e.g. employee's readiness, leadership styles of the supervisor and supervisors training framing). Thirdly, although a substantial amount of variance in dependent measures explained by the significant predictors is identified, there are still a number of unexplainable factors that can be incorporated to identify the causal relationship among variables and their relative explanatory power [Tabachnick et al. 2001]. Finally, the sample for this study was taken using a convenient sampling technique in a single public university. These limitations may decrease the ability of generalizing the results of this study to other university settings.

The above limitations were adjudged to be unavoidable. However, some of them that accompanied this study could be overcome in future research if firstly, the organizational and personal characteristics that may act as a potential variable and can influence the effectiveness of supervisor's

role in training programs should be further explored, which would help to provide meaningful perspectives for understanding the individual differences and similarities that affect motivation to learn. Secondly, the weaknesses of cross-sectional research design may be overcome if longitudinal studies are used to collect data and describe the patterns of change and the direction and magnitude of causal relationships between variables of interest. Thirdly, the findings of this study may produce different results if this study is done in more than one university. Finally, as an extension of the motivation to learn, future researchers should consider other theoretical constructs of organizational climate (e.g. transfer of competency, training policy and procedures, facilities, budget and employee readiness) because they have been widely recognized as an important link between supervisor support and training outcomes [Yamnil & McClean 2001, Blanchard, Thacker 2007, Ismail et al. 2007].

CONCLUSION

The findings of this study confirm that supervisor's role (supervisor support and supervisor communication) does act as an important predictor of motivation to learn in the organizational sample. In this sense, the two study hypotheses (H1 and H2) have been supported. In the context of this study, supervisors have provided adequate support (e.g., encourage employees to attend training programs and apply newly acquired knowledge and skills that they gain from training programs in their jobs) and used comfortable communication style (e.g. provide feedback, encourage discussion and openly deliver information on training) when dealing with training programs. This practice has increased employees' motivation to learn necessary knowledge, up to date skills, new skills and positive attitudes in the organization.

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ROLA NADZORUJĄCEGO W PROGRAMACH SZKOLENIOWYCH JAKO MENADŻERA PROGRAMU NAUCZANIA

STRESZCZENIE. Zgodnie z literaturą dotycząca zagadnień szkoleniowych, rola nadzorującego w programach szkoleniowych składa się z dwóch głównych elementów: wsparcie nadzorującego i komunikacji nadzorującego. Umiejętność efektywnego wypełniania obu tych elementów przez prowadzących szkolenie może zwiększyć motywację pracowników do nauki. Charakter tej wzajemnej zależności jest interesujący, ale na rolę nadzorującego jako przewidywalnej zmiennej w modelach programu szkoleniowego jest kładziony zwykle mniejszy nacisk. Z tego powodu przeprowadzono badania w celu określenia wpływu roli nadzorującego w programach szkoleniowych na motywację do nauki. Posłużono się ankietą przeprowadzoną wśród 152 pracowników pozaakademickich, którzy pracowali w technicznej uczelni publicznej w Malezji. Wyniki analizy regresji wykazały, że wsparcie nadzorującego i komunikacji nadzorującego są istotnie związane z motywacją do nauki. Wyniki statystyczne wykazały, że rola nadzorującego w programach szkoleniowych jest ważnym predykatorem motywacji do nauki w próbie organizacyjnej. Przedstawiono dyskusję oraz wnioski tych badań.

Słowa kluczowe: rola nadzorującego w programach szkoleniowych, motywacji do nauki, Malezja.

DIE ROLLE DES VORGESETZTEN IN AUSBILDUNGSPROGRAMME ALS LEHRPLAN-MANAGER

ZUSAMMENFASSUNG. Nach Angaben der Literatur über die Ausbildung, die Rolle des Vorgesetzten hat zwei wichtige Elemente: die Unterstützung des Vorgesetzten und die Kommunikation des Vorgesetzten. Die Fähigkeit des Vorgesetzten zur effektiven Durchführung dieser beiden Elemente kann die Motivation der Arbeitnehmer zu lernen erhöhen. Die Natur dieser Beziehung ist interessant, aber auf die Rolle des Vorgesetzten als berechenbare Variable in einem Ausbildungsprogramm-Modelle ist weniger Wert gelegt. Aus diesem Grund wurde diese Studie durchgeführt, um die Wirkung der Rolle des Vorgesetzten in Ausbildungsprogramme auf die Lernmotivation zu bestimmen. Der Fragebogen wurde unter 152 nicht-akademische Mitarbeiter, die in den technischen staatlichen Hochschulen in Malaysia gearbeitet haben, durchgeführt. Die Ergebnisse der Regressionsanalyse zeigten, dass die Unterstützung des Vorgesetzten und die Kommunikation des Vorgesetzten wesentlich mit der Lernmotivation verbunden sind. Statistische Ergebnisse zeigten, dass die Rolle des Vorgesetzten in den Ausbildungsprogramme ein wichtiger Prädiktor für Lernmotivation in die Stichprobe ist. Zusätzlich sind die Diskussion und Schlussfolgerungen aus diesen Studien präsentiert.

Codewörter: Rolle des Vorgesetzten in Ausbildungsprogramme, Motivation zu lernen, Malaysia.

Muhammad Madi Bin Abdullah
International Business School (IBS),
Universiti Teknologi Malaysia International Campus,
Kuala Lumpur, Malaysia
E-mail: drmuhdmadi@gmail.com / mbbaroto@ic.utm.my

Mas Bambang Baroto
International Business School (IBS),
Universiti Teknologi Malaysia International Campus,
Kuala Lumpur, Malaysia
E-mail: mbbaroto@ic.utm.my

Azman Ismail
Faculty of Defence and Management Studies,
National Defence University of Malaysia,
Sungai Besi Camp. 57000 Kuala Lumpur, Malaysia
E-mail: azisma08@gmail.com

Huam Hon Tat
Faculty of Management and Human Resource Development,
Universiti Teknologi Malaysia,
Johor, Malaysia
E-mail: huam@utm.my

Corresponding author
Muhammad Madi Bin Abdullah
E-mail: drmuhdmadi@gmail.com

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 2
No 3

http://www.logforum.net

ESTIMATION OF SUPPLIERS AS AN IMPORTANT ELEMENT OF THE RATIONALIZATION OF SUPPLY PROCESSES – CASE STUDY

Dawid Doliński, Adam Koliński

Institute of Logistics and Warehousing, Poznan School of Logistics, Poznań, Poland

ABSTRACT. To increase the efficiency of the business in times of the globalization and increasing competition, the management of the companies looks for opportunities to achieve higher incomes or to reduce the costs of inputs. One of possible methods to obtain higher efficiency is to put the emphasize on the relationships with suppliers. This is very important element of an effective management of the company, because by determining the economical conditions of the cooperation, it is possibly to reduce the cost of business activities. The reliable classification of the suppliers is depended on the level of the detail of an assessment criteria and the scoring method. The main problem is the risk of the objective estimation of individual offers received from the suppliers. For this reason, the classification of suppliers is one of the key problems of the logistics controlling. Based on practical example, this paper presents the complexity of the problem of the classifications and the selection of suppliers according to different hierarchy of the importance of various criteria.

Key words: logistics controlling, analysis of suppliers, procurement, purchasing.

INTRODUCTION

The basic economical aim of each company is the profitability. It means that the company must earn to be able to develop and fulfil various social functions. The purchasing of raw materials and services necessary to performs tasks of the company is one of the important elements, which affects the rentability of the company. Therefore, the Purchasing Department, which aims to reduce the costs and influences the profitability of the whole company, plays an important role in this company. It is particularly important in the conditions of the economic slowdown or even the financial crisis in the global markets. The strong trend to centralize the purchasing activities in large-scale enterprises, corporations or holdings can be observed in recent years. The unification of these processes aims to the selection of key suppliers and to the creation of the cooperation based on partner relationships. In long terms, it leads to rationalizing of procurement processes. Therefore, the reliable assessment of the suppliers according to various criteria is an important element of the process. In addition, the process of the selection of the suppliers should not be based only on the lowest prices offered by them. Quite often, the logistic conditions could be more important than the lower price, because from point of view of all processes (purchasing, logistics and sales) the supplier offering the lowest price could be, in fact, the more expensive one. The aim of this paper is to present one of the mechanisms to evaluate the supplier. The Authors present the method of the selection of the supplier based on a specific numerical scoring system, which takes into account the specific criteria for individual branches of business. The criteria having an impact on the selection of the supplier in food industry are presented in this paper.

Citation: Doliński D., Koliński A., 2011, Estimation of suppliers as an important element of the rationalization of supply processes - case study. LogForum 7, 2, 3
URL: http://www.logforum.net/vol7/issue2/no3
Accepted: 11.04.2011, on-line: 5.05.2011.

CASE STUDY OF THE EVALUATION OF SUPPLIERS AS THE PERFORMANCE TO OPTIMIZE THE PROCESS OF PROCUREMENT

According to J.J.Coyle [2003] and K.Lyson [2006], the process of procurement consists of 11 steps. However, within this case study, only a part of these activities will be analyzed with particular emphasis on the evaluation of the conditions of the cooperation with selected suppliers to identify the key supplier for the analyzed raw materials. The following actions will be conducted:

- identification of possible suppliers,
- pre-selection of possible sources of the supply,
- evaluation of other suppliers,
- selection of the supplier.

The suppliers of key raw materials necessary for production are:

- Supplier 1 – D1,
- Supplier 2 – D2,
- Supplier 3 – D3,
- Supplier 4 – D4,
- Supplier 5 – D5.

The nine criteria of the evaluation of suppliers were chosen and their importance for the company was determined as follows:

1. Price S1,
2. Quality of raw material S2,
3. Punctuality of deliveries S3,
4. Terms of payments S4,
5. Discounts S5,
6. Terms of complains and returns S6,
7. Approach to client's demands S7,
8. Transport S8,
9. Packaging S9.

It should be emphasized, that the hierarchy of established criteria are not significantly different from European standards, which results from a study conducted by H.Ch.Pfhol [2010]. In order to maintain the strong market position, companies often are obliged to compete in the area of an offered price and the use of optimal logistics processes. The price is the main cost driver of purchased raw materials. Therefore, this criterion is considered as the main criterion of the selection of the suppliers used by many companies, operating on Polish, European as well as global market. The similar importance is put on the quality criterion, which has a strong impact on the attractiveness of the products and ensures their marketability. The companies strive to manufacture the products by the use of raw materials of the highest quality, which are often inspected in the laboratories for the compliance with appropriate standards. The punctuality of deliveries is important for the companies due to increasing expectations of the effectiveness of the logistics customer service. This factor is also important in the processes related to the optimization of the stocks levels, because the shorter lead-times enable to keep lower levels of safety stock as well as the periodic stock used for current needs.

The three above-mentioned criteria (price, quality, punctuality of deliveries) play the leading role in the companies and form the core of logistics and management activities. In practice, the big majority of the companies in Poland use mainly these criteria in processes related with the selection of

suppliers. The criteria following above-mentioned ones, in the order of their importance, are trade criteria, like payment conditions or discounts. These criteria have an impact on financial management, cash flow and the level of the capital invested in stocks of raw materials (acting capital). The terms of complains and returns as well as the approach to customers' needs are also important, as they affect positively on the material flow management in the company. The transport and package criteria were classified at the last position due to the high popularity of the outsourcing of transport processes and hence the forwarders and logistics operators are responsible for these factors, which optimize them on their own.

The price level is measured using the comparative scale. This scale determines the ranking of suppliers according to the price level for a product.

Table 1. Price measure
Tabela 1. Miara ceny

Level	I	II	III	IV	V
Points	10	7	5	2	1

Source: own work

The quality of the raw material is measured as the percent of raw materials inconsistent with the quality standards (level of shortages).

Table 2. Measurement of the quality
Tabela 2. Mierzenie jakości

Percentage of shortages	0-2%	3-5%	6-10%
Points	10	8	4

Source: own work

The punctuality of the deliveries is measured as a number of days of delays in the order fulfilment. The date of the delivery is confirmed each time by the suppliers within 24 hour after receiving the order.

Table 3. Measurement of the punctuality of the deliveries
Tabela 3. Mierzenie terminowości dostaw

Days	0-2	3-4	5-7	8-10
Points	10	8	5	1

Source: own work

The terms of payment are considered with regard to two elements: the crediting of the deliveries and non-cash settlement option.

Table 4. Measurement of the terms of payment
Tabela 4. Mierzenie warunków płatności

Element	yes	no
Crediting of deliveries	5 points	0 points
non cash settlements	0 points	5 points

Source: own work

The discounts are measured as the percentage of discount offered by the supplier for the order amount of 10000 PLN.

Table 5. Measurement of discounts
Tabela 5. Mierzenie upustów cenowych

Percentage	0-1%	2-3%	4-5%	6-7%	8-10%
Points	0	2	4	6	8

Source: own work

The terms of complains and returns are measured in days, within which the raw material can be claimed or returned to the supplier.

Table 6. Measurement of terms of complains
Tabela 6. Mierzenie warunków reklamacji

Days	0-2	3-6	7-9	10-11	12-14
Points	1	4	6	8	10

Source: own work

The customer's requirements are the subjective evaluation conducted at various management levels (operational staff, managers of purchasing departments, management board). The following types of behaviours were distinguished: flexible – 10 points, negotiating – 5 points, inflexible – 0 points.

The comparison of transport conditions was made by the comparison of the terms of the cooperation with suppliers:

- the supplier covers transport costs – 10 points,
- the supplier does not cover transport costs – 0 points.

The 50 kilograms boxes were determined as the most convenient ones for the transport purposes (with loading and unloading processes) for the analyzed case.

Table 7. Measurement of the importance of the package
Tabela 7. Mierzenie znaczenia opakowania

Kilograms per box	20 kg	50 kg	100 kg
Points	7	10	2

Source: own work

The determination of weights of the criteria is also very important in addition to the selection of these criteria. The method to determine the importance of the weight in the hierarchy of the criteria is shown in Table 8. The criterion S1 (price) was placed at the higher position in the hierarchy (the frequency of advantage over other criteria – 8).

Table 8. Weights of criteria
Tabela 8. Wagi dla poszczególnych kryteriów

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**Frequency of advantage**	**Weight**
S1		x	x	x	x	x	x	x	x	8	0,222
S2			x	x	x	x	x	x	x	7	0,194
S3				x	x	x	x	x	x	6	0,167
S4					x	x	x	x	x	5	0,139
S5						x	x	x	x	4	0,111
S6							x	x	x	3	0,083
S7								x	x	2	0,056
S8									x	1	0,028
S9										0	0,00
Total										**36**	**1,00**

Source: own work

The Table 9 shows the results of the study of terms of the cooperation with suppliers with regard to analyzed criteria.

Table 9. Terms of the cooperation with suppliers
Tabela 9. Warunki współpracy z dostawcami

	Supplier 1	**Supplier 2**	**Supplier 3**	**Supplier 4**	**Supplier 5**
Price	1,14 zł/kg	1,20 zł/kg	0,95 zł/kg	0,98 zł/kg	1,06 zł/kg
Quality	1% of shortage	4% of shortage	7% of shortage	5% of shortage	8% of shortage
Punctuality	6 days of delay	3 days of delay	7 days of delay	1 day of delay	5 days of delay
Terms of payment	non-cash without credits	non-cash without credits	cash credits	non-cash without credits	cash credits
Discounts	2% at 10 000 PLN	7% at 10 000 PLN	3% at 10 000 PLN	3% at 10 000 PLN	5% at 10 000 PLN
Terms of complains and returns	up to 6 days	up to 10 days	up to 9 days	up to 7 days	up to 12 days
Approach to client's requirements	negotiating	flexible	negotiating	inflexible	flexible
Transport	not provided	provided	not provided	not provided	provided
Packaging	20 kg per box	50 kg per box	50 kg per box	20 kg per box	100 kg per box

Source: own work

The Table 10 shows the points obtained by every supplier without taking into account the weights of the criteria.

Table 10. The score of suppliers
Tabela 10. Punktacja dostawców

	D1	**D2**	**D3**	**D4**	**D5**
S1	2	1	10	7	5
S2	10	8	4	8	4
S3	5	8	5	10	5
S4	0	0	10	0	10
S5	2	6	2	2	4
S6	4	8	6	6	10
S7	5	10	5	0	10
S8	0	10	0	0	10
S9	7	10	10	7	2
Total	**35**	**61**	**52**	**40**	**60**

Source: own work

Based on the results presented in the Table 10, it can be concluded, that the best supplier is the Supplier 2 (D2), because it received the highest amount of the points, which means it offers the best services among potential suppliers of raw material. However, this supplier received only a slight advantage over the supplier at the second place (60 points – Supplier 5 – D5). The supplier D1 (Supplier 1) definitely received the lowest amount of points (35). The above presented results do not take into consideration the significance of discussed criteria.

The Table 11 shows the points obtained by every supplier with taking into account the weights of the criteria.

Table 11. The score of suppliers with taking into consideration the weight of criteria
Tabela 11. Punktacja dostawców z uwzględnieniem wag

	Weight	**D1**	**D2**	**D3**	**D4**	**D5**
S1	0,222	0,444	0,222	2,222	1,556	1,111
S2	0,194	1,944	1,556	0,778	1,556	0,778
S3	0,167	0,833	1,333	0,833	1,667	0,833
S4	0,139	0,000	0,000	1,389	0,000	1,389
S5	0,111	0,222	0,667	0,222	0,222	0,444
S6	0,083	0,333	0,667	0,500	0,500	0,833
S7	0,056	0,278	0,556	0,278	0,000	0,556
S8	0,028	0,000	0,278	0,000	0,000	0,278
S9	0,000	0,000	0,000	0,000	0,000	0,000
Total	**1,000**	**4,056**	**5,278**	**6,222**	**5,500**	**6,222**

Source: own work

Taking into the consideration the weight of criteria in the process of selection of the best supplier, it turned out that two companies are the best ones: Supplier 3 (D3) and Supplier 5 (D5).

The Supplier D2 has the first position with 61 points in initial estimations, but after the verification of these estimations by the application of weights of criteria, this supplier became the next to last position. In the first phase of calculations without the application of weights of criteria, the Supplier D2 was dominant, because it gained the highest scores in three last criteria (of lowest weight): transport, package and approach to client's requirements. Regarding the criteria of key importance for the company, the scores of D2 range from minimum to almost maximum, but they do not have a bigger impact on final results. In the contrast to surprising results, gained by Supplier D2, the result of Suppliers D5 is the situation, which could be expected. It reached the second position with 60 points in initial classification (practically the same as D2), but after taking into consideration the weights of criteria, it reached the first position. It is a result of the consistent balancing between maximal and minimal point values for each criterion (usually obtaining the average ones) as well as collecting the highest amount of maximal points. The interesting situation is the case of the Supplier D3, which "jumped" from last positions to the first one. It resulted from the lowest price, which is the most important criterion. The Supplier D3 does not received any points or only small number of points in case of low rated criteria, which also does not affect or affects only very slightly its position in the ranking after taking into consideration the weights of criteria.

Comparing the two "winning" (after taking into consideration the weights of criteria) suppliers, the Supplier D5 was better in the matter of secondary criteria, gaining three times the maximum amount of points. The Supplier D3 is definitely the better one in the matter of criteria, being most important for the company, where it gained twice the maximal amount of points while Supplier D5 achieved only average values there. As these criteria are more important, it seems to be reasonable to prefer the Supplier D3.

SIMULATION OF CHANGES IN THE CRITERIA HIERARCHY OF SELECTION OF SUPPLIERS

Due to the ongoing discussion and the dispute between Logistics Department and Trade Department regarding the method of the determination of an appropriate hierarchy of importance of the criteria, the simulation of two possible variants were conducted. These variants applied the different hierarchy of importance of the criteria. The quality criteria, logistics, and operational criteria (punctuality, packaging, transport, possibility of returns) were of the same importance in the first

variant. The suppliers, which offer favourable financial conditions (low price, crediting of supplies, discounts) are preferred in the second variant.

Variant I (Logistics Variant)

The hierarchy of the importance of the criteria:

1. Quality of raw materials S2
2. Punctuality of deliveries S3
3. Packaging S9
4. Transport S8
5. Terms of complains and returns S6
6. Approach to client's requirements S7
7. Price S1
8. Discounts S5
9. Terms of payments S4

The determination of the weight of the criteria.

Table 12. The determination of the weight of criteria in Variant I
Tabela 12. Określenie wag w Wariancie I

	Frequency of advantage	Weight
S1	2	0,0556
S2	8	0,2222
S3	7	0,1944
S4	0	0,0000
S5	1	0,0278
S6	4	0,1111
S7	3	0,0833
S8	5	0,1389
S9	6	0,1666
Total	**36**	**1**

Source: own work

The comparison of points with taking into account the weights of criteria.

Table 13. The comparison of points with taking into account the weights in Variant I
Tabela 13. Zestawienie punktów z uwzględnieniem wag w Wariancie I

	Weight	D1	D2	D3	D4	D5
S1	0,0556	0,111	0,056	0,556	0,389	0,278
S2	0,2222	2,222	1,778	0,889	1,778	0,889
S3	0,1944	0,972	1,556	0,972	1,944	0,972
S4	0,0000	0,000	0,000	0,000	0,000	0,000
S5	0,0278	0,056	0,167	0,056	0,056	0,111
S6	0,1111	0,444	0,889	0,667	0,667	1,111
S7	0,0833	0,417	0,833	0,417	0,000	0,833
S8	0,1389	0,000	1,389	0,000	0,000	1,389
S9	0,1666	1,167	1,667	1,667	1,167	0,333
Total	**1**	**5,389**	**8,333**	**5,222**	**6,000**	**5,917**

Source: own work

The winner of the simulation of the variant oriented on the logistics aspects of the cooperation is the Supplier D3. The low level of returns (4%), good punctuality of deliveries and very good characteristics of the packaging characterize it.

Variant II (Financial Variant)

The hierarchy of the importance of the criteria:

1. Price S1
2. Discounts S5
3. Terms of payments S4
4. Quality of raw materials S2
5. Terms of complains and returns S6
6. Punctuality of deliveries S3
7. Packaging S9
8. Transport S8
9. Approach to client's requirements S7

The determination of the weight of the criteria.

Table 14. The determination of the weight of criteria in Variant II
Tabela 14. Określenie wag w Wariancie II

	Frequency of advantage	Weight
S1	8	0,2222
S2	5	0,1389
S3	3	0,0833
S4	6	0,1667
S5	7	0,1944
S6	4	0,1111
S7	0	0,0000
S8	1	0,0278
S9	2	0,0556
Total	**36**	**1**

Source: own work

The comparison of points with taking into account the weights of criteria.

Table 15. The comparison of points with taking into account the weights in Variant II
Tabela 15. Zestawienie punktów z uwzględnieniem wag w Wariancie II

	Weight	D1	D2	D3	D4	D5
S1	0,2222	0,444	0,222	2,222	1,556	1,111
S2	0,1389	1,389	1,111	0,556	1,111	0,556
S3	0,0833	0,417	0,667	0,417	0,833	0,417
S4	0,1667	0,000	0,000	1,667	0,000	1,667
S5	0,1944	0,389	1,167	0,389	0,389	0,778
S6	0,1111	0,444	0,889	0,667	0,667	1,111
S7	0,0000	0,000	0,000	0,000	0,000	0,000
S8	0,0278	0,000	0,278	0,000	0,000	0,278
S9	0,0556	0,389	0,556	0,556	0,389	0,111
Total	**1**	**3,472**	**4,889**	**6,472**	**4,944**	**6,028**

Source: own work

The winner of the simulation of the variant oriented on the financial aspects of the activities of the company is the Supplier D3. It was the best business partner, offering the optimal business terms and conditions:

- lowest price,
- terms of payments – very good (the possibility of non-cash settlements and the crediting of supplies),
- discounts – acceptable (3% at 10 000 PLN).

SUMMARY

The analysis of four different variants were conducted: without taking into account the weight of criteria, with taking into account the weight of criteria, a logistics variant (importance of logistics criteria) and a financial variant (importance of financial criteria). The Table 16 presents the summary of the scoring and ranking of the suppliers in each analyzed variant.

Table 16. The ranking of suppliers for each variant
Tabela 16. Ranking dostawców dla poszczególnych wariantów

	Ranking of suppliers and points		
Variant	Supplier 1	Supplier 2	Supplier 3
Without weights	D2 - 61	D5 - 60	D3 - 40
With weights	D3 - 6,22	D5 - 6,22	D4 - 5,50
Logistics	D2 - 8,33	D4 - 6,00	D5 - 5,92
Financial	D3 - 6,47	D5 - 6,03	D4 - 4,94

Source: own work

According to the above table, both the Supplier D2 (in the variant without weight and logistics one) and the Supplier D3 (in the variant with weights and financial one) became twice the winner. The Supplier D2 is much better from the logistics point of view, while the Supplier D3 is preferred by the Trade Department because of the low price. One should be also aware, that the streamlining of logistics processes needs much more efforts to be put in, than the negotiation of appropriate terms and conditions.

The proposal to resign from the condition, that the Supplier D2 covers the transport costs, is the additional argument to choose this supplier. The Trade Department could negotiate the prices of raw materials, so that the reduction of the price would compensate the cost of own transport. It should be emphasized that, the Supplier D3 does not provide nor cover transport costs, which affects negatively its final position in the comparison, because in case of successful price negotiations with the Supplier D2, both the Supplier D2 and the Supplier D3 could be price comparable.

As a conclusion of this comparison of suppliers, it should be emphasized that, the method of estimation of suppliers could be introduced in the company only if it will be incorporated into organizational structures of this company. The formalization of this process as a procedure of this company is an important element, which is underlined by Magdalena Dąbrowska-Mitek [2008]. The implementation of a clear procedure, including instructions of proceedings in each step, the responsibilities, and the frequency of individual actions gives the clear overview, how this process should function. The formalized and described process is also more protected against the fluctuation of employees and allows monitoring continuously the effectiveness of the process of the estimation of suppliers.

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OCENA DOSTAWCÓW JAKO ISTOTNY ELEMENT RACJONALIZACJI PROCESÓW ZAOPATRZENIA - CASE STUDY

STRESZCZENIE. W czasach globalizacji i narastającej konkurencji, aby zwiększyć efektywność działalności gospodarczej, kadra kierownicza przedsiębiorstw szuka możliwości osiągnięcia większego przychodu lub oszczędności ekonomicznych w postaci obniżenia kosztów nakładów. Jednym ze sposobów zwiększenia efektywności jest skupienie uwagi na relacjach z dostawcami. Jest to niezwykle ważny element efektywnego zarządzania przedsiębiorstwem, gdyż poprzez określenie ekonomicznych warunków współpracy, można wpłynąć na obniżenie kosztów działalności gospodarczej. Rzetelna klasyfikacja dostawców jest uzależniona od szczegółowości opracowanych kryteriów oceny oraz sposobu punktacji. Zasadniczym problemem jest ryzyko obiektywnej oceny poszczególnych ofert, otrzymanych od dostawców. Z tego względu proces klasyfikacji dostawców jest jednym z kluczowych problemów controllingu logistyki. W niniejszym artykule autorzy podjęli próbę przedstawienia na praktycznym przykładzie złożoności problemu klasyfikacji i wyboru dostawców względem różnej hierarchii ważności poszczególnych kryteriów.

Słowa kluczowe: controlling logistyki, analiza dostawców, zaopatrzenie, zakupy.

DIE BEWERTUNG DER LIEFERANTEN ALS EIN WESENTLICHES ELEMENT DER RATIONALISIERUNG DES BESCHAFFUNGSPROZESS – EINE FALLSTUDIE

ZUSAMMENFASSUNG. In der Zeiten der Globalisierung und des anwachsenden Wettbewerbs, die Führungskräfte der Unternehmen suchen nach Möglichkeiten der größeren Einkommen oder ökonomischen Ersparnissen in Form der Senkungen von Kosten um die Effektivität der Unternehmen zu steigern. Eine der Methoden zur Steigerung der Effektivität ist auf die Beziehungen mit Lieferanten zu konzentrieren. Das ist ein äußerst wichtiges Element der effektiven Unternehmensverwaltung, da durch richtige Bestimmung der ökonomischen Bedingungen der Zusammenarbeit, kann die Senkung der Unternehmenskosten erreicht sein. Die zuverlässige Klassifizierung der Lieferanten ist abhängig von der Ausführlichkeit der Bewertungskriterien und des System der Punktwertung. Das Hauptproblem ist das Risiko der objektiven Bewertung der einzelnen Angebote der Lieferanten. Aus diesem Grund ist das Prozess der Klassifizierung der Lieferanten eines der wichtigsten Probleme des Logistik-Controllings. Die Autoren dieser Artikel, basierend auf ein praktisches Beispiel, versuchten die Komplexität des Problems der Klassifizierung und der Auswahl von der Lieferanten gegenüber verschiedenen Hierarchie der Wichtigkeit der verschiedenen Kriterien zu präsentieren.

Codewörter: Logistik-Controlling, Analyse von Lieferanten, Beschaffung, Einkaufen.

mgr inż. Adam Koliński
Poznan School of Logistics
mgr Dawid Doliński
Institute of Logistics and Warehousing
ul. Estkowskiego 6
61-755 Poznań, Poland
e-mail: dawid.dolinski@ilim.poznan.pl

LogForum

> Scientific Journal of Logistics <

http://www.logforum.net

ISSN 1734-459X
2011
Vol. 7
Issue 2
No 4

INFORMATION IN THE CITY TRAFFIC MANAGEMENT SYSTEM. THE ANALYSIS OF THE USE OF INFORMATION SOURCES AND THE ASSESSMENT IN TERMS OF THEIR USEFULNESS FOR CITY ROUTES USERS

Maciej Szymczak[1], Katarzyna Sienkiewicz-Małyjurek[2]

1) Poznań University of Economics, 2) Silesian University of Technology, Poland

ABSTRACT. Solving problems connected with the flow of cargo and people in cities demands taking a system approach and integrating a number of activities. One of effective methods of improving traffic, and what is even more important, the one possible to be promptly introduced, is to implement Intelligent Transport Systems. It makes it possible to significantly enrich information resources for managing the city traffic. Nonetheless, to achieve satisfactory results, one has to consider information needs of public transport users and provide them with convenient access to information to enable them to plan their journeys more effectively. This article presents the results of research conducted on two urbanized areas, namely the Poznan conurbation and the Upper Silesian Industrial Region. The research aim was to determine which information sources city routes users use and how they assess their usefulness.

Key words: city traffic management, city transport, local public transport, city logistics.

INTRODUCTION

The competitiveness of modern cities and their development dynamics depend more and more on the progress of knowledge and innovation. This progress has resulted in the quality of city transport systems, which has been included in "The National Transport Policy for 2006-2025" ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Modern transport systems face many problems. Apart from being overloaded, they do not correspond with specific features of cities and their residents' transport needs. Furthermore, they negatively impact on the level of environmental sustainability. All the aforementioned as well as transport inefficiency (traffic congestion); decrease the life quality of city residents, instead of improving it. The inefficiency of transport systems results in the first place in long city journeys time and a time loss, which it entails. Furthermore, public transport efficiency is reduced, while the danger of collisions and accidents is on the increase. This translates into higher costs of journey and external costs that the natural environment incurs. Functioning in the conditions of congestion, modern transport systems users not only have to be exceptionally patient, but, first of all, they have to be able to manage their time in a flexible manner. It refers to both journeys made with own means of transport and with public transport.

Solving the problems connected with the flow of cargo and people in cities needs taking a comprehensive and system approach, as increasing the quality of roads and their traffic capacity has physical limitations determined by road infrastructure whose development is in turn limited by the

Citation: Szymczak M., Sienkiewicz-Małyjurek K., 2011, Information in the city traffic management system. The analysis of the use of information sources and the assessment in terms of their usefulness for city routes users. LogForum 7, 2, 4
URL: http://www.logforum.net/vol7/issue2/no4
Accepted: 11.04.2011, on-line: 5.05.2011.

architecture of a given city, not to even mention budget constraints. One of main tasks included in the National Transport Policy for 2006-2025 is "promoting innovative technical solutions, e.g. by encouraging the development of traffic management systems which prioritize means of public transport in traffic, by using traffic control systems for public transport vehicles with the application of satellite navigation, by developing dynamic passenger information systems, etc." ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Therefore, an effective method to make the flow of cargo and people in cities more efficient is Intelligent Transport Systems (ITS) with one of their basic components common for all the others, namely information. This article is devoted to solutions, which aim to provide city transport system users with information in the real time. The user is understood here as a person controlling a mechanical vehicle (carrying cargo or people) and a passenger in means of public transport. This study aims to analyse how city routes users use individual available sources of information and to evaluate how useful such sources are. The research was conducted on two urbanized areas, namely the Poznań conurbation and the Upper Silesian Industrial Region. The research results will be useful in developing city traffic management systems based on dynamic and current access to information, taking into consideration transport systems users' information needs. At present, many Polish conurbations are developing such systems, while the other ones only face a necessity of their implementation.

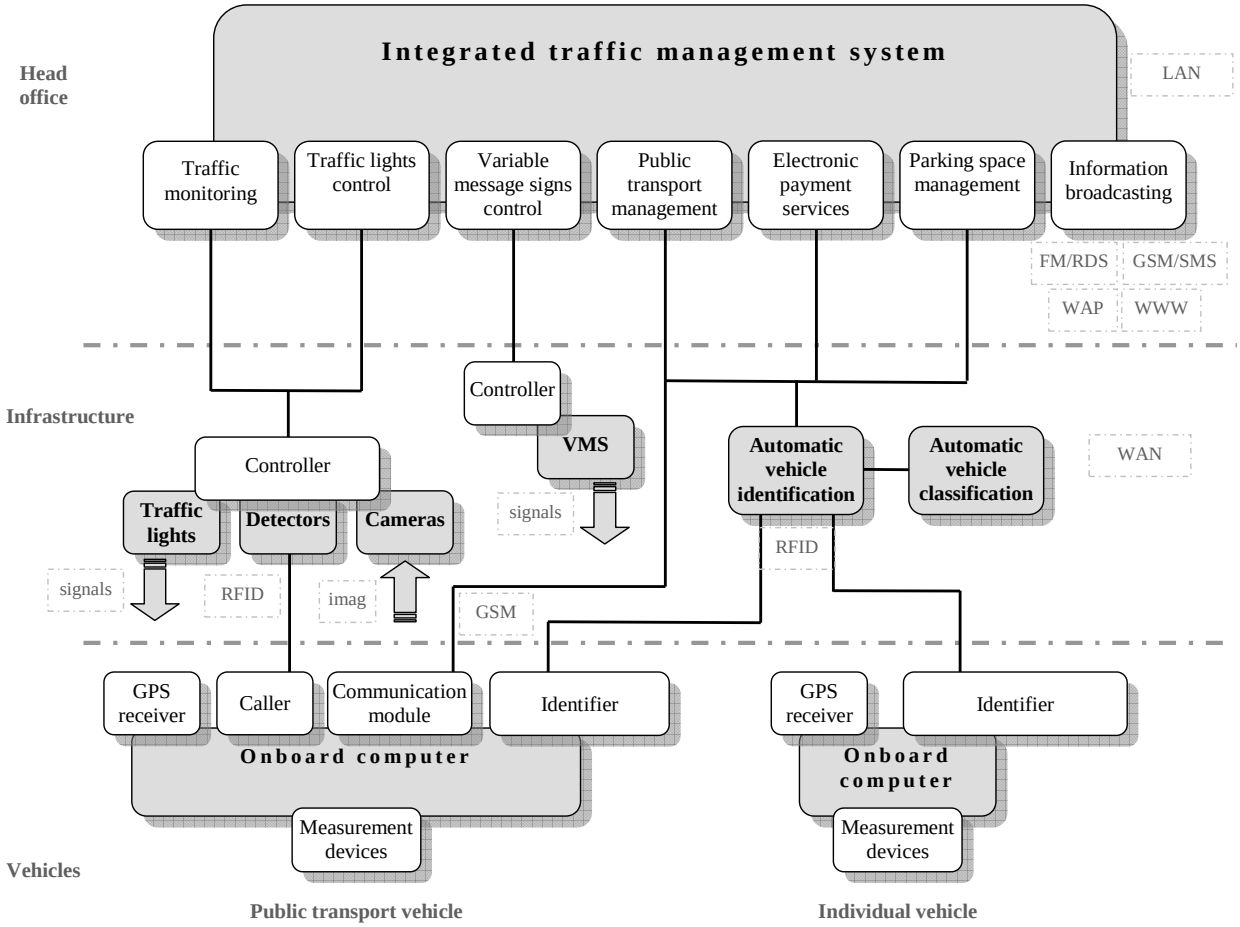
CITY TRAFFIC MANAGEMENT SYSTEM

Intelligent Transport Systems have been developed from the synergy of existing technological solutions. They respond to increasing problems of modern transport systems, including first of all continuous traffic growth, air pollution, noise and users' safety being at risk. "ITS serve both individual and public transport. ITS are mainly implemented to: improve safety and comfort of journeys, quality of information and its availability, increase mobility, and make city transport more efficient. ITS also aim to reduce the number of road accidents, congestion level and costs it entails (e.g. time loss, fuel consumption, environmental pollution). In addition, the objective of ITS is to improve the functioning of city logistics system, and, as a result, to increase city competitiveness in the long-term" [Sienkiewicz-Małyjurek, Szymczak 2008]. City traffic management systems are one of ITS components.

The last decade has seen a dynamically growing number of systems in place which aid traffic management in cities. New applications have been created, which control activities, facilitate transport and flow of information among services operating in this area, which has contributed to considerable integration of activities. A city management system is a set of tools and techniques used for such activities as [Szymczak 2008]:

- extensive permanent monitoring of road traffic, including both intensity of traffic and its structure in terms of its direction and type, with a special focus on city public transport vehicles;
- traffic lights control in a dynamic mode on the basis of information from traffic monitoring;
- control of information transmitted on road signs and variable message signs (VMS) - the transmission of information is made on the basis of information from traffic monitoring;
- registering random incidents (vehicle breakdowns, accidents) and traffic violations both for the purpose of reorganizing temporary traffic and preparing the evidence.

Basic components of the integrated traffic management system include the traffic monitoring system, traffic lights control system, variable message signs control system, and the city public transport management system. The system may be also extended by additional subsystems and applications connected with them, including automatic traffic information over the RDS radio tuner, through the Short Message Service and on the Internet. Information is a component common for all modes of the city traffic management system. The structure of the integrated traffic management system is shown in Figure 1.

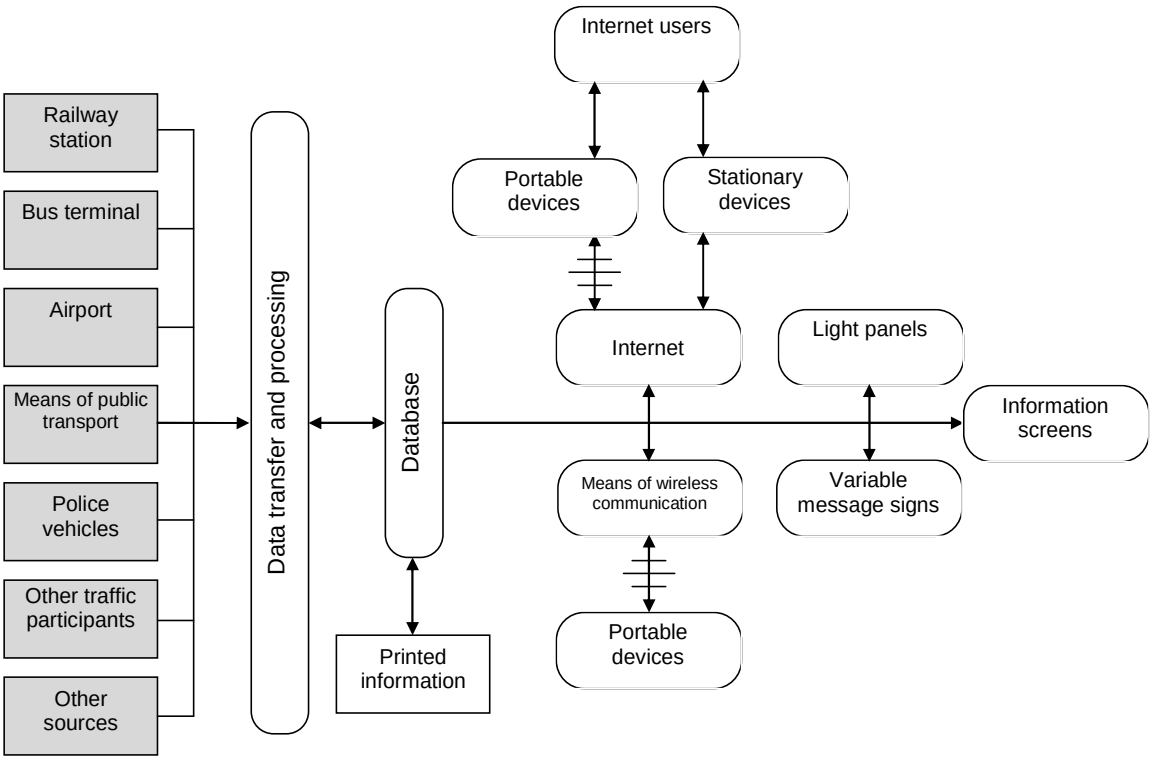


Source: Szymczak 2008

Fig. 1. The structure of the integrated city traffic management system
Rys. 1. Struktura systemu zintegrowanego zarządzania ruchem miejskim

TRANSPORT INFORMATION SYSTEMS

Transport information systems make one of ITS components. They are used to gather and analyse data from many sources, and then to transfer such data to transport system users in the real time. Examples of such systems include Trafficmaster, ADVANCE, FASTTRAC, VICS, and ATIS. They cover city road networks, motorways, city ring roads, dual carriageways, railway routes, waterways and airports. The data gathered and analysed is presented on the Internet, can be sent by the radio or mobile communications as well transmitted to every mobile receiving device. It is used by local authorities, residents, tourists and any other interested person. Transport Information Systems consist of permanent elements presented on Figure 2.



Source: Own study on the basis of Zongqi, Zhihong 2008

Fig. 2. The structure of the transport information system
Rys. 2. Struktura systemu informacyjnego transportu

Transport systems users can use the information from the transport information system to plan their journeys in terms of the choice of transport and route, and also to modify an earlier chosen route to avoid or limit various dangers during their journey. For passengers using roads with their own means of transport, the most useful information concerns the traffic congestion level, traffic incidents, recommended diversions, changes in traffic organization, free parking spaces, etc. Public transport users have similar information needs, except that they are additionally interested in the access to transport services information, public transport arrivals and departures, delays, and changes of routes, etc. Commercial car and lorry drivers have yet other needs. They need information about burden limitations, axle load, allowed vehicle dimensions (e.g. height of flyovers), restrictions for lorries, car parks for lorries, petrol stations with high pressure petrol pumps, etc. Such individual needs have been also considered by satellite navigation maps producers and producers of the first devices designed specially for lorry drivers [GPS dla trakerów 2009].

There are many methods of distributing information about the current traffic situation. The most popular is the mass media, with a prevailing role of radio transfer which may be supplemented by text information provided in an additional channel in RDS TP/TA (Radio Data System - Traffic Programme / Traffic Announcement) in the analogue radio broadcasting in the VHF band or transmitted within digital radio broadcasting DAB (Digital Audio Broadcasting). Also the Short Message System and Multimedia Messaging System frequently serve the purpose of distributing information. DAB and MMS enable sending pictures such as situation drawings of changes in traffic organization or schematic diversion plans.

Another source of information, though currently useful mainly before starting a journey, is internet technologies (The possibility of using internet resources and services during a journey may soon become widely available. The Internet use is already possible in some luxury passenger cars such as a new Audi A8 (the function is placed on the driver's central console, it is available wireless for

passengers) and in modern means of public transport through mobile Wi-Fi hot spots. Such a service has been offered since 1 September 2010 in the newest buses operated by Wiraż-Bus - a public carrier of Swarzędz, a municipality located near Poznań [Ewing 2010; http://wiraz-bus.cba.pl]). City halls, road directorates, and independent companies run internet services.

Information about city traffic is of dynamic nature, which is why they should be promptly transferred. "Information gathering, analyzing and transferring should take from 5 seconds to 1 minute" [Zongqi, Zhihong 2008]. S. Kenyon and G. Lyons identified three types of passenger-targeting information [Lyons 2006]:

- Unimodal Traveller Information (UTI) - the simplest and most frequent form of informing passengers, e.g. information boards, road atlases, internet maps; it has a wide spectrum of use, but is relevant only to a specific scope of information;
- Multimodal Traveller Information (MTI) - information about more than one mode of transport, made available on the basis of access to a range of information sources;
- Integrated Multimodal Information (IMMI) - enables to compare passengers' needs with current traffic conditions; it uses a number of data sources and makes it possible to prepare various content compilations.

Transport information systems facilitate smooth flow of cargo and people in a dense network of roads on urbanized areas. IMMI presents the highest information value for passengers. This kind of information transfer can be personalised for a specific group of users, and even for one defined user, which in addition increases the usefulness of this information channel.

The are many services in the world, where city routes users can find necessary information. The use of such information depends first of all on individual needs and its potential users. Research conducted in Great Britain among transport systems users show that basic information which passengers seek includes information about traffic limitations and a possibility of planning one's route. The results of this research are presented in Table 1.

Table 1. Basic types of information, which passengers seek in information services
Tabela 1. Podstawowe rodzaje informacji, poszukiwanych przez pasażerów w serwisach informacyjnych

Type of information	**Number of responses (in %)**
Road traffic limitations during a journey	87
Possibility of planning a journey	80
Potential time of a journey	73
Total cost of a journey	66
Possibilities of purchasing a ticket	56
Transport costs depending on means	54
Reasons for selecting means of transport	43

Source: Lyons 2006

In cities worldwide there are information portals, which are very frequently really advanced, where it is possible to obtain information useful both for drivers and public transport users, city residents and tourists.

RESEARCH RESULTS

In December 2009 and January 2010, the authors conducted surveys among public transport users and passenger car drivers. The research was carried out on two urbanized areas, namely the Poznań conurbation and the Upper Silesian Industrial Region. The research aim was to determine which information sources city routes users use and how they assess their usefulness. All surveys were responded to in the presence of a survey conducting person ready to explain any respondents' doubts so as to prevent any negative impact of such on the final results. Only a small number of surveys was filled by a survey conducting person via a telephone conversation with a respondent. The surveys were anonymous. Table 2 and 3 compile filled surveys subject to the analysis.

Table 2. Surveys compilation - the Poznań conurbation
Tabela 2. Zestawienie wyników ankiet w aglomeracji poznańskiej

Age	Public transport users		Drivers		
	Women	Men	Women	Men	
under 25	15	10	14	17	
26-40	14	14	13	15	
41-60	16	12	12	16	
above 60	14	11	9	13	Total
	59	**47**	**48**	**61**	**215**

Source: own study

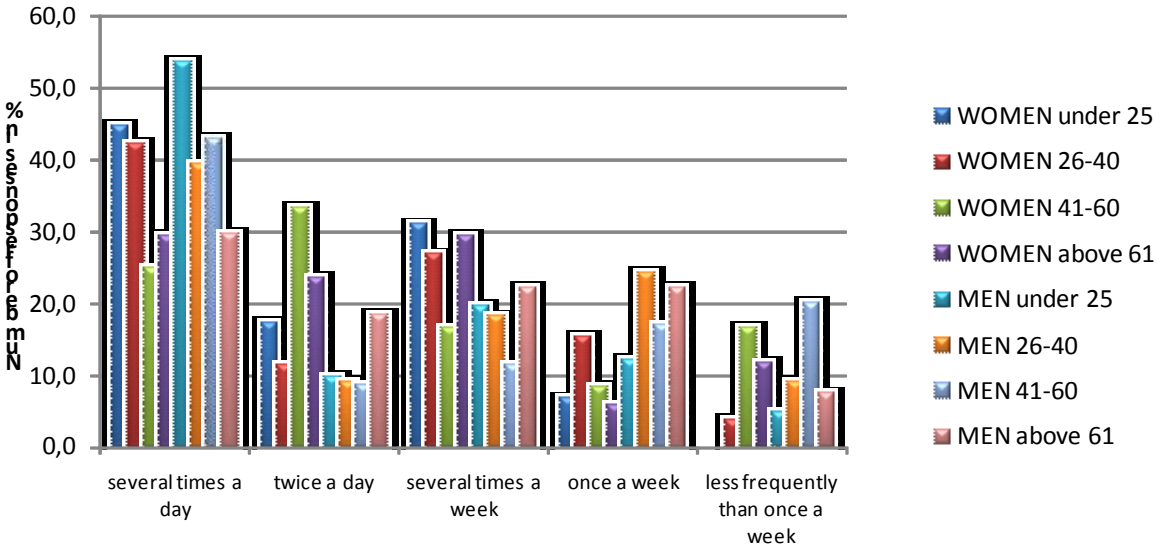
Table 3. Surveys compilation - the Upper Silesian Industrial Region
Tabela 3. Zestawienie wyników ankiet w Górnośląskim Okręgu Przemysłowym

Age	Public transport users		Drivers		
	Women	Men	Women	Men	
under 25	16	10	15	24	
26-40	10	12	13	18	
41-60	15	10	12	19	
above 60	12	13	8	14	Total
	53	**45**	**48**	**75**	**221**

Source: own study

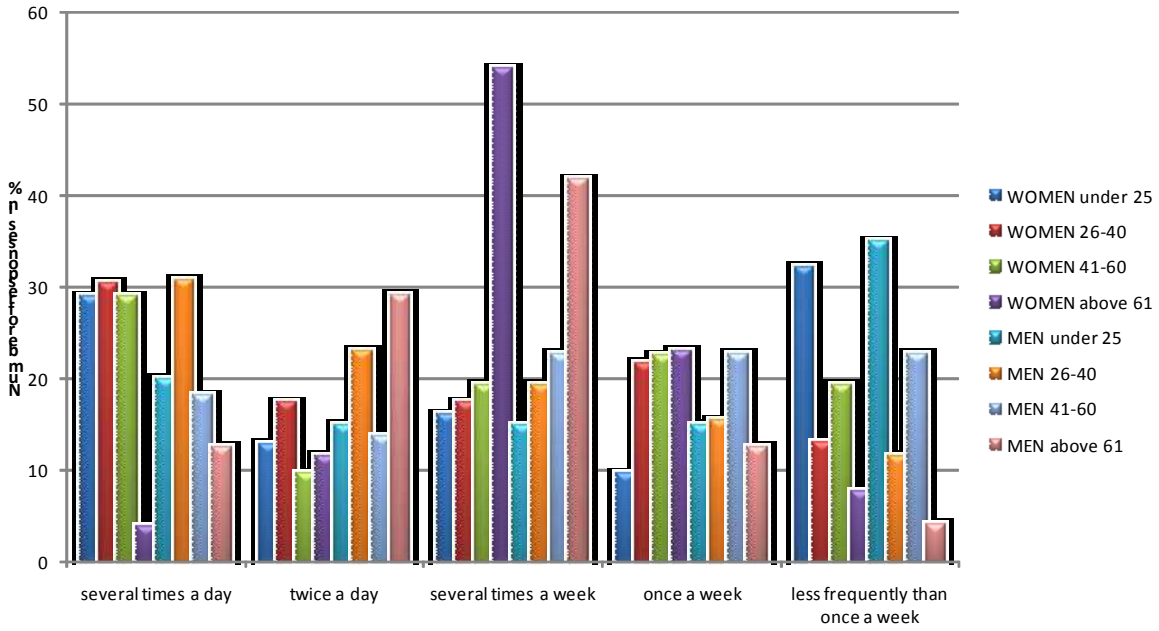
The analysis of the research results indicates that no differences exist in terms of the frequency of using public transport, its assessment or using information sources about journey conditions among public transport users in both analyzed areas, i.e. the Poznań conurbation and the Upper Silesian Industrial Region. The results lead to a conclusion that there are also no differences as far as respondents' sex and education are concerned. Different behaviours and opinions are only observed while considering respondents' age.

The diagnosis of the Polish transport system lists the following main trends: a fall in public transport share (by about 20-25%) in the local transport in most cities due to an increase of individual transport share to 60-70% in that transport and higher users' expectations as to individual transport subsystems (such as comfort, reliability, safety, journey time, journey certainty, low costs, etc.) ["Polityka Transportowa Państwa na lata 2006-2025" 2005]. Such trends have been confirmed in the conducted research, which shows that 54.8% drivers use their car for transport purposes every day (see Figure 3). It is mainly drivers under 25 (62.7% in this age band). On the contrary, a car as an everyday means of transport is the least used by respondents aged 41-60 (16.7% of women and 20.2% of men). A lower frequency has been observed in the case of public transport use (see Figure 4). As little as 22.2% of users use public transport several times a day, while 25.6% - several times a week. It is respondents aged above 61 (47.8%) and 41-60 (18.8%) that use this transport most often.



Source: own study

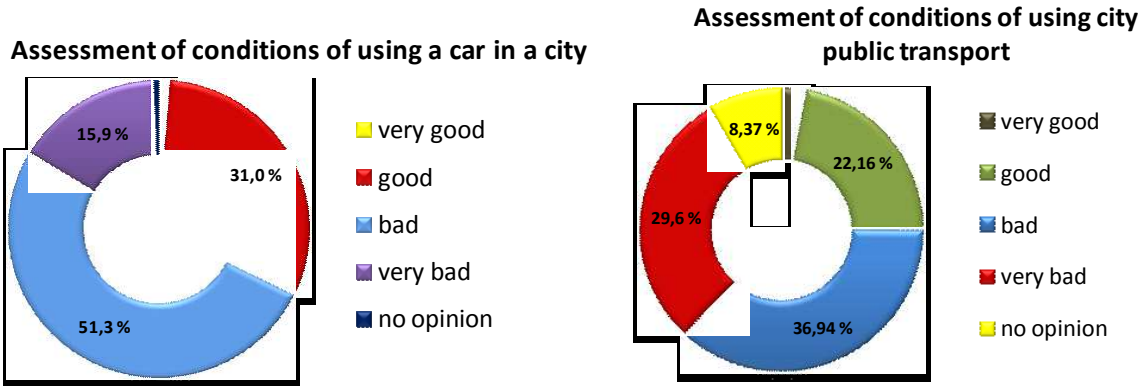
Fig. 3. Frequency of using a car for transport purposes in a city.
Rys. 3. Częstotliwość korzystania z samochodu w celach transportowych w mieście



Source: own study

Fig. 4. Frequency of using public transport.
Rys. 4. Częstotliwość korzystania z transportu publicznego

The analysis of drivers' opinions shows that 67.1% of them negatively assess (score assessment 1 and 2) conditions of using a car in a city. Likewise, 66.5% public transport users give the negative assessment of their journey conditions. The results of opinion research are shown in Figure 5.



Source: own study

Fig. 5. The assessment of using a car and public transport in a city
Rys. 5. Ocena warunków korzystania z samochodu i transportu publicznego w mieście

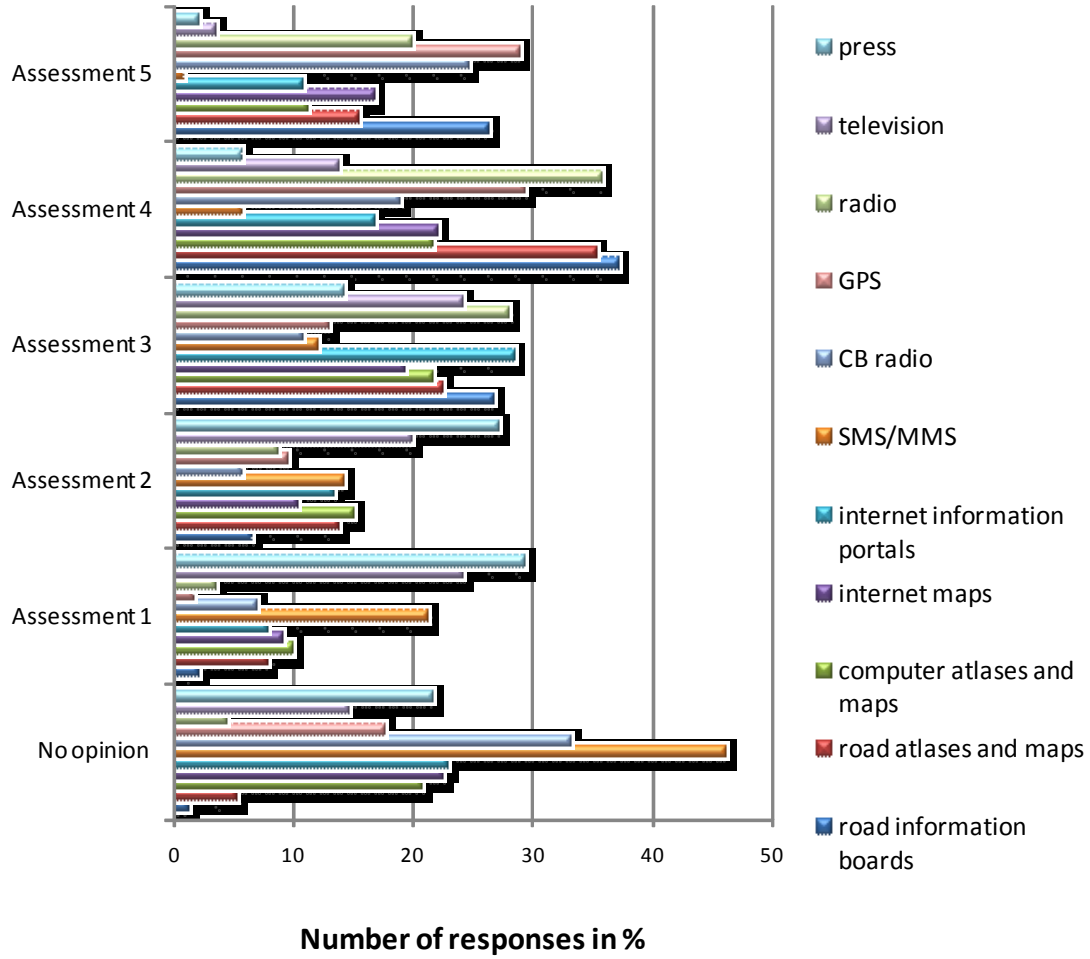
Main tasks listed in "The National Transport Policy for 2006-2025" include developing of the application of modern technical and organizational solutions is such areas as dynamic drivers information systems and passenger information systems. The analysis of assessments given as to the usefulness of information sources while using a car as a means of transport indicates that drivers most frequently use:

- road information boards (63.4% responses),
- GPS with maps (58.2%),
- the radio (55.6%),
- road atlases and maps (50.9%),
- CB radio (43.5%).

The least used source of information is SMS and MMS. It was clearly indicated by respondents - 46.1% of them have never used such services. This fact is due to the low popularity of road SMS and MMS in Poland (It can be stated that in Poland systems informing drivers about current traffic intensity through SMS and MMS have only started to develop. An important stage of this development is the Auto Świat Finder service that has been activated recently by one of popular car magazines. When a driver sends an appropriately formulated text message (PLN 2.44), a multimedia message is sent back with information about traffic incidents and a small map depicting driving conditions of roads subject to question (what needs to be given by a driver is a city name, a street name or a road number) ["Nie daj się zakorkować" 2010]). This situation may not change soon as 35.3% of respondents marked this information channel as the least efficient in terms of its usefulness (score assessment 1 and 2). The press and television were most frequently assessed as poor sources of information (56.5% and 43.9% respectively). These sources turn useful mainly before setting off and, compared with the radio or CB radio they lose in terms of providing up-to-date information. The compilation of usefulness assessments of individual information sources for drivers is displayed in Figure 6. It is mainly younger respondents that use modern technological solutions. Their major source of information is internet maps and CB radio (46.1% and 53.8% respectively). The situation looks different in the over 40 age band - here respondents use first of all traditional road atlases and maps (74.5%) and road information boards (69.9%). What strikes attention is that in every age band the same assessments were given for GPS systems (score assessments from 3 to 5) as a modern technology and the radio as a traditional source of information (56.5% and 51.2% respectively).

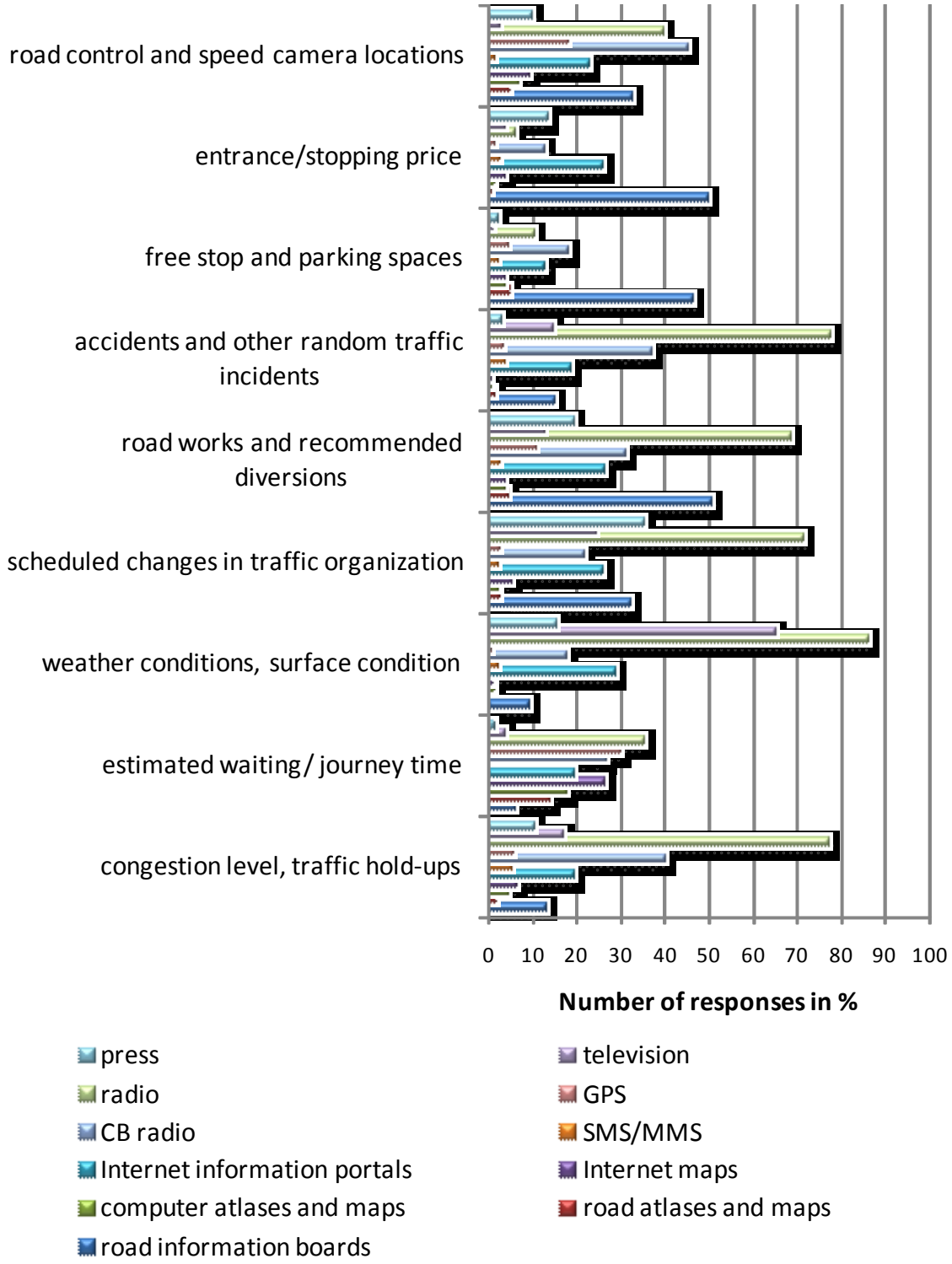
To obtain a more in-depth view of the results, the analysis was made of information sources selected for a particular purpose of information, which is shown in Figure 7. It indicates the radio as

a still very important source of information for vehicle drivers. It is the most frequently used form when drivers need information about accidents and other random traffic incidents (77.6% responses), the congestion level (77.1%), scheduled changes in road traffic organization (71.1%), road works and recommended diversions (68.6%), and weather conditions (86.2%). The comfort of use while driving and up-to-date information constitute a decisive factor for selecting the radio as a source of information.



Source: own study

Fig. 6. Assessment of information sources in terms of their usefulness for drivers (5- the highest score, 1- the lowest score).
Rys. 6. Ocena źródeł informacji w odniesieniu do ich użyteczności dla kierowców (5- najwyższa ocena, 1- najniższa)



Source: own study

Fig. 7. Sources of information used by drivers for information purposes
Rys. 7. Źródła informacji używane przez kierowców w celach informacyjnych

City public transport users use different sources of information. In their opinion, the most useful ones (marked with the highest score) include:

- information at public transport stops (75.9% of responses),
- the Internet (62.1%),

– electronic timetable (44.8%).

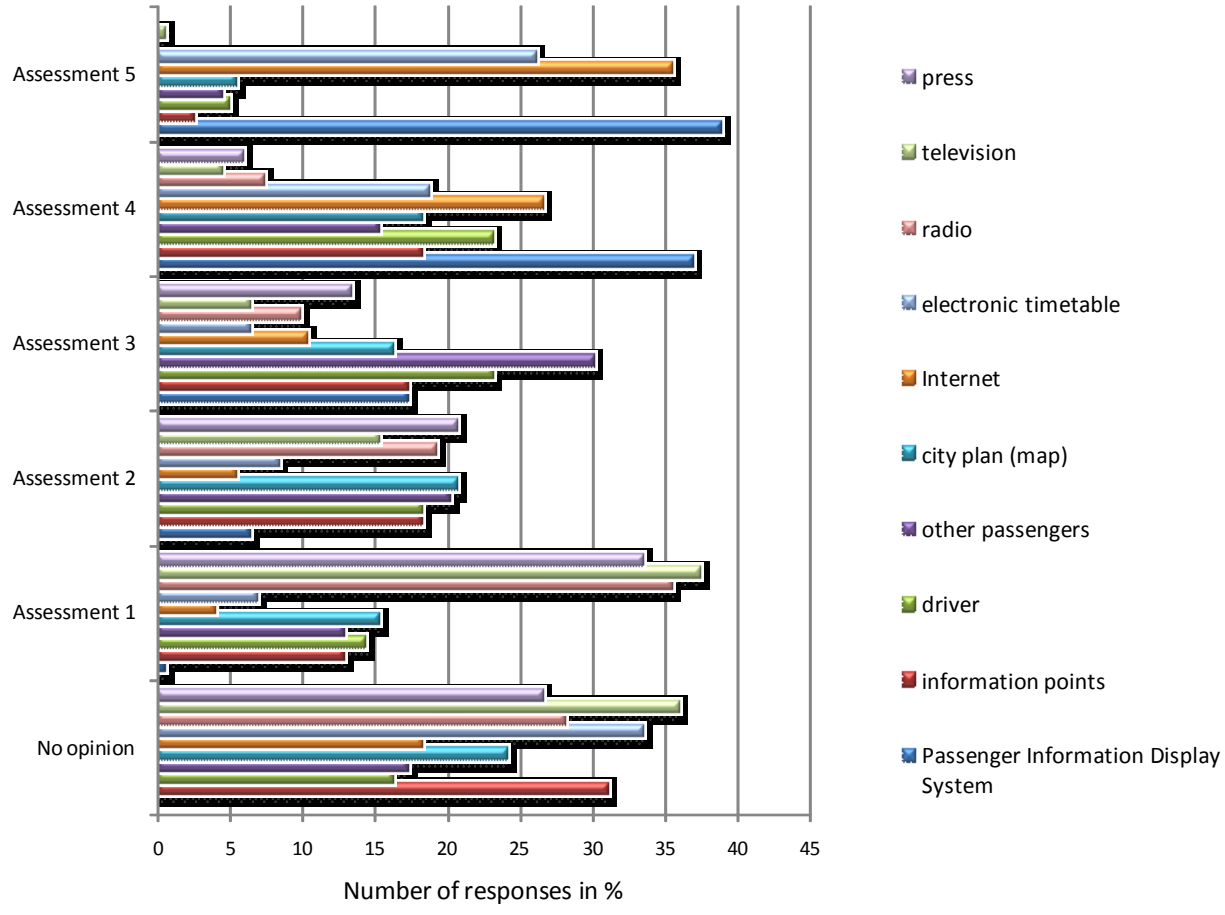
On the contrary, the least useful sources of information given by respondents (marked with the lowest score) are:

– the radio (54.7%),

– the television (52.7%),

– the press (54.2%).

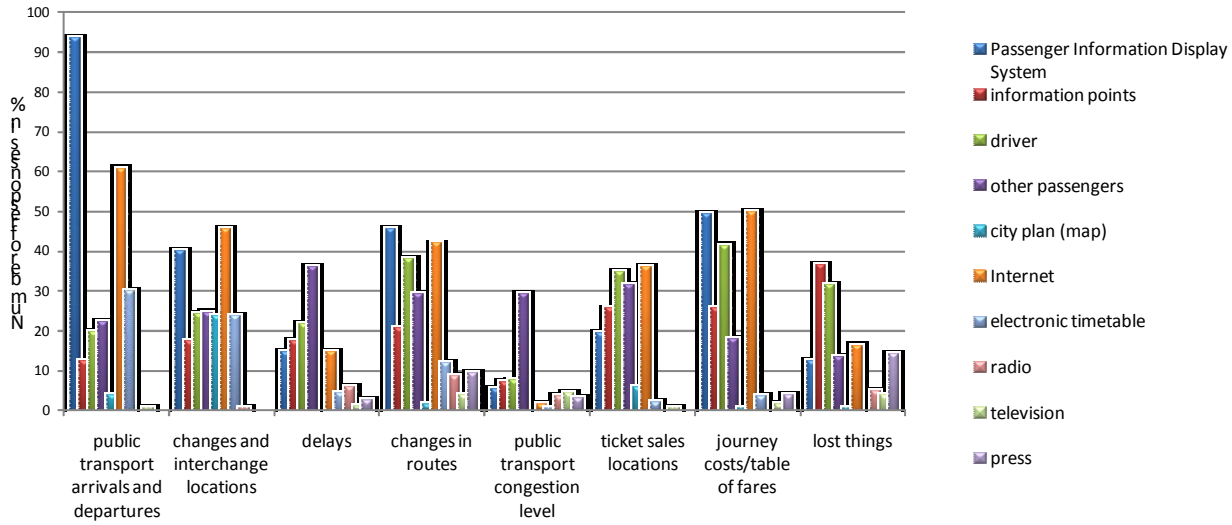
The compilation of usefulness assessments of individual information sources for public transport users is displayed in Figure 8. Again no differences have been identified as to the usefulness of information sources regarding the sex. As in the case of private car drivers, younger respondents use modern technological solutions more often. Such a phenomenon has been shown in the assessment of information sources usefulness. The electronic timetable has been positively assessed (score assessments 3 to 5) by 86.3% respondents under 25, 48.9% of respondents aged 26-40, 37.7% of respondents aged 41-60, and by only 5.9% of respondents above 61. The use of the Internet as an information source indicates even more significant differences with regard to the age of public transport users. This source of information was positively assessed by 80.4% of respondents under 25, 81.6% at the age 26-40, 71.7% at the age 41-60 and as little as 10.1% of respondents over 61.



Source: own study

Fig. 8. Assessment of information sources in terms of their usefulness for public transport users (5- the highest score, 1- the lowest score).
Rys. 8. Ocena źródeł informacji w odniesieniu do ich użyteczności dla użytkowników transportu publicznego (5- najwyższa ocena, 1- najniższa)

Public transport users most often seek information about public transport arrivals and departures, change possibilities, interchange locations, delays in public transport services, changes in routes, congestion level and journey costs, etc. On both analyzed urban areas public transport users can choose from a variety of passenger information sources. To obtain information about public transport arrivals and departures, users most often select the Passenger Information Display System (93.6% of responses) and the Internet (accounts for 60.6% of responses). Likewise, in the case of information about changes in routes - the most frequently used information sources include the Passenger Information Display System, and the Internet (45.3% and 41.9% respectively), while with regard to changes - it is 39.9% and 45.3% of responses respectively, and journey costs - 49.3% and 49.8% respectively. Figure 9 compiles assessments of individual information sources in terms of their usefulness for public transport users.



Source: own study

Fig. 9. Sources of information used by public transport users with regard to their information needs
Rys. 9. Źródła informacji używane przez użytkowników transportu publicznego w związku z ich potrzebami informacyjnymi

CONCLUSIONS

Drawing on the considerations given in this study, secondary sources and analyses of empirical research results it may be concluded that:

- analysing the role of information in the city traffic management it should be stated that from the view of a transport system user, whom access to information enables to make a conscious choice as to available journey possibilities, not only does it have an essential role in the current planning of traffic and its control to shorten journey time and increase traffic safety, but is of strategic importance in establishing a sustainable transport system, which will make it possible to implement the best division of tasks between the public and individual transport taking into consideration residents' mobility on the one hand and the environmental burden from the other hand;
- for the information to serve its purpose, it has to be up-to-date and be as much available as possible both before and during a journey, bearing in mind its easiness to be obtained by transport system users; it demands the communication of transport information systems with mass media, the Internet and local information and communication technologies systems which

use in the first place wireless connections (e.g. mobile communications, Wi-Fi hot spots) given hugely popular personal mobile devices;

- the obtained research results indicate that transport system users in cities use a number of sources: car users most often use the CB radio, traditional road maps and atlases, the radio, GPS, road information boards, while public transport users use first of all the Passenger Information Display System, the Internet and growing in popularity electronic timetables;
- different behaviours and opinions of transport system users regarding the frequency of use and the assessment of individual information sources are only visible while considering respondents' age - a place of residence, sex, and education are virtually of no importance here;
- the analysis of transport system users' information needs compared with the detailed analysis of information mostly sought after in information portals allows to identify residents and visitors' transport needs, which constitutes relevant information to better traffic management in cities and, in the long term, to planning transport system development;
- as not all respondents were aware of some information sources being available and a method of access to some information channels, it is important to state that of great importance is informing the society by mass media about new information and communication technologies and initiatives concerning services for car drivers and public transport users.

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INFORMACJA W SYSTEMIE ZARZĄDZANIA RUCHEM MIEJSKIM. ANALIZA WYKORZYSTANIA I OCENA PRZYDATNOŚCI ŹRÓDEŁ INFORMACJI DLA PORUSZAJĄCYCH SIĘ PO MIEŚCIE

STRESZCZENIE. Rozwiązywanie problemów, jakie wiążą się z przepływami ładunków i osób w miastach wymaga podejścia systemowego oraz zintegrowania wielu działań. Jednym ze skutecznych sposobów usprawnienia ruchu, a co ważniejsze możliwym do szybkiego wdrożenia jest implementacja Inteligentnych Systemów Transportowych, co pozwala na znaczne wzbogacenie zasobów informacji dla zarządzania ruchem miejskim. Aby jednak efekt był zadowalający należy uwzględnić potrzeby informacyjne kierowców i pasażerów środków transportu zbiorowego oraz zapewnić im dogodny dostęp do informacji, aby mogli lepiej planować swoje podróże. Artykuł zawiera wyniki badań, jakie przeprowadzone były na dwóch obszarach zurbanizowanych - w aglomeracji poznańskiej oraz na terenie Górnośląskiego Okręgu Przemysłowego. Celem badania było określenie, z jakich źródeł informacji korzystają poruszający się po mieście oraz jak oceniają przydatność tych źródeł.

Słowa kluczowe: zarządzanie ruchem miejskim, transport miejski, lokalny transport zbiorowy, logistyka miejska

INFORMATION IM VERWALTUNGSSYSTEM DES STADT-VERKEHRS. ANALYSE DER BENUTZUNG UND BEWERTUNG DER NÜTZLICHKEIT DER INFORMATIONSQUELLEN FÜR STADT-VERKEHRSTEILNEHMER

ZUSAMMENFASSUNG. Die Lösung von Problemen, die mit dem innerstädtischen Personen- und Güterverkehr verbunden sind, verlangen nach einer planmäßigen Behandlung und Integration von vielen Wirkungen. Eine der wirksamsten Weise der Stadtverkehrsverbesserung, die möglich zum schnellen Einführung ist, ist die Implementation von Intelligenten Transportsystemen, was erlaubt, bedeutend die Informationen für das Verwaltungssystem des Stadtverkehrs zu bereichern. Damit der Effekt zufriedenstellend ist, soll man Informationsbedürfnisse von Fahrern und Passagieren von Transportmitteln des öffentlichen Verkehrs berücksichtigen und ihnen bequemen Informationszugang sichern, damit Sie besser ihre Reisen planen könnten. Der Artikel umfasst Ergebnisse von Untersuchungen, die man auf zwei urbanisierten Gebieten -in der Poznań - Agglomeration und im Oberschlesischen Industriegebiet durchgeführt hat. Das Ziel von Untersuchungen war die Bestimmung, welche Informationsquellen die Verkehrsteilnehmer benutzen und wie die Nützlichkeit von diesen Quellen bewerten.

Codewörter: Verwaltung des Stadtverkehrs, Stadtverkehr, öffentlicher Verkehr, Stadtlogistik

dr hab. Maciej Szymczak, prof. nadzw. UEP
Poznań University of Economics, Poznan, Poland
ph. (61) 856 92 55, fax (61) 856 92 58
e-mail: maciej.szymczak@ue.poznan.pl
Katarzyna Sienkiewicz-Małyjurek
Silesian University of Technology

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 2
No 5

http://www.logforum.net

FORECASTING OF DEMAND FOR DIRECT PRODUCTION MATERIALS AS THE ELEMENT OF SUPPLY LOGISTICS OF THERMAL POWER PLANTS

Agata Mesjasz-Lech

Czestochowa University of Technology, Czestochowa, Poland

ABSTRACT. The paper highlights the problems associated with the process of forecasting realized within the supply logistics in thermal power plants. The theoretical part focuses on the importance of forecasting of inventories of raw materials in thermal power plants and the quality of logistics decisions determined by utilitarian value of data obtained, stored, processed and transmitted within the logistic system. The practical part presents the results of studies conducted in one of the thermal power plants in the south of Poland and the results of forecasting of the demand for the materials directly used in manufacturing process.

Key words: inventory management, utilitarian value of data, forecasting, forecasting methods.

INTRODUCTION

The production of the high-quality electricity in the quantities sufficient to cover energy requirements of households and business enterprises is the main goal of power plants. Due to the fact, that the energy cannot be stored, the main importance of the inventory management of power plants is put on the management of raw materials, and especially the raw materials, which are necessary to ensure the continuity of the production process. Therefore, the primary objective of the purchasing is to ensure the availability of needed raw materials for the production at a minimum cost. The forecasting of the demand for raw materials is one of the most important activities determining the effectiveness of the inventory management.

The paper presents the results of studies conducted in one of the power stations located in the south part of Poland. Its main goal is to identify the factors, which affect the demand level of production raw materials as well as to present the possibilities of the forecasting process of the demand in power plants. The attempt was made to find the best possible method of the forecasting of the demand for the coal, which is the main source of the energy.

Citation: Mesjasz-Lech A., 2011, Forecasting of demand for direct production materials as the element of supply logistics of thermal power plants. LogForum 7, 2, 5
URL: http://www.logforum.net/vol7/issue2/no5
Accepted: 1.06.2011, on-line: 20.06.2011.

THE IMPORTANCE OF FORECASTING OF STOCKS LEVEL OF RAW MATERIALS IN LOGISTIC PURCHASMENT SYSTEM

The production of the high-quality electricity in the quantities sufficient to cover energy requirements of households and business enterprises is the main goal of power stations. Due to the fact, that the energy cannot be stored, the main importance of the inventory management of power plants is put on the management of raw materials, and especially the raw materials, which are necessary to ensure the continuity of the production process. The inventory is one of the main components of logistic processes and should be characterized by the efficiency and the flow profitability [Sarjusz-Wolski and Skowronek 2003]. The efficiency ensures the complete cover of requirements of participants of the logistic processes and the flow profitability ensures the optimal cost level. The primary objective of the purchasing is to ensure the availability of needed raw materials for the production at a minimum cost. The forecasting of the demand for raw materials is one of the most important activities determining the effectiveness of the inventory management. The inventory management is very important for the company due to the facts that [Twaróg 2003]:

1. The inventory costs are an important part of total logistic costs,
2. The stocks levels impact the customer service level,
3. The costs regulations of trade-off types affect the costs of inventory maintenance.

The support of the decision making process is the main goal of the forecasting, particularly at the tactical level [Syntetos et. al. 2010]. This goal determines functions of the forecasts in the company, namely [Cieślak 2005]:

1. Preparation – the forecasting is the activity, which prepares other activities,
2. Activation – the designated forecasts are the incentives to undertake actions leading to reach the goals or to oppose them, depending on the balance of benefits and losses, which could be obtained by the company,
3. Information – to indicate the changes in forecasted occurrences and to reduce the uncertainty of the future events.

The purposefulness of forecasting activities results from the conditions under which the company operates, and particularly from the conditions of the uncertainty. In case of the procurement, they are determined by [Tempelmeier 2000]:

- demand levels for raw materials, which could vary throughout the planning period,
- unknown replenishment time (the purchase of the following stock batch),
- the discrepancy between ordered and delivered quantity of goods,
- the lack of the consistency between the inventory records, conducted by the inventory staff and the actual inventory level (inventory differences).

In addition, the companies are supplied by different suppliers and therefore the risk connected with lead-time can occur. The risk and the uncertainty are inseparable elements of the way, how the company functions, and therefore they cannot be eliminated. However, due to the properly conducted forecasting process, they can be reduced to the level, which does not threaten the functioning of the company. The knowledge of the future demand levels supports the process of constructing of replenishment plans. The corrected chosen methods of forecasting of the future demand are the conditions of the correctness of replenishment plans [Syntetos and Boylan 2010]. The right information as well as data of appropriate characteristics are necessary to fulfil this goal.

THE UTILITARIAN VALUE OF INFORMATION FOR FORECASTING OF THE DEMAND FOR RAW MATERIALS' STOCKS

The quality of logistic decisions depends mainly on the utilitarian value of data obtained, stored, processed and transmitted within the logistic system of the company. The date passes on the contents of a message, which presents the information. The management of the information of the appropriate utilitarian value is necessary to the correct realisation of the forecasting process. The following features determine the utilitarian value of the information: timeless, relevancy, completeness, ease of understanding and reliability [Bukowski 2004]. The definitions (stated by Bukowski [2004]) and the exemplary characteristics of each feature in accordance to the requirements for the procurement about the correct forecasting of raw materials for the production company are presented in the table 1.

Table 1. Characteristics of utilitarian value of information for the demand planning of stocks levels of raw materials
Tabela 1. Cechy wartości użytkowej informacji na potrzeby planowania popytu na zapasy surowcowe

Characteristics	Definition	Examples
timeless	monotonically not increasing function of the delay, with which the information reaches the decision maker	▪ information on stocks levels of raw materials, which are updated periodically ▪ information on the demand for a raw material in a given period of the time ▪ cost of stocks maintaining of raw materials for a given time or a period of the time
relevancy	the compliance of the information with the needs of the user	▪ the recording of each stock movement (and not only stocks level at weekly periods) in order to estimate the point of placing the orders
completeness	the difference between the source information and the information obtained by the user	▪ identification of methods to estimate the missing data
ease of understanding	the usefulness of the information for the direct use by the decision maker	▪ keeping the cost records according to logistics requirements to assess the raw materials' supply processes
reliability	the compliance of the information with the situations described by this information	▪ the information on stocks levels of raw materials recorded always by the use of the same method ▪ depreciation deduction calculated with the use of the same rates throughout the whole depreciation period (in order to eliminate the creativity in the accounting)

The access to the information of high utilitarian value increases the effectiveness of logistics systems. The access to data and the appropriate logistics information is necessary for the analysis, estimation and finally making the right decision to realize the aims of the logistics. It should be pointed out, that only one numerical value does not mean anything. The observation of any event in only one moment of the time or a period provides only one worthless value [Jetzke 2007]. It is necessary to possess the whole set of data, which creates information, which fulfill all conditions for it to be of a utilitarian value.

THE APPLICATION OF SELECTED METHODS FOR THE FORECASTING OF THE DEMAND OF RAW MATERIALS USED DIRECTLY IN THE PRODUCTION IN POWER PLANTS

The raw materials used directly in the production process belong to the tangible assets. They are characterized by the total consumption in the production process and ensuring its undisturbed course [Cebrowska 2005]. Therefore, each unit of these materials should have the stocks of raw materials of proper structure and in sufficient quantities to ensure its proper functioning. Such raw material used directly in production process of power plant is the fuel, which is processed into the electric and thermal energy. The hard coal is the traditional raw material used in power plants. The energetic coal is characterized by:

- calorific value, i.e. the combustion heat and the combustion value,
- humidity,
- content of combustible compounds,
- ash content,
- content of sulphur and other trace elements,
- milling susceptibility.

The caloric value determines the amount of the coal, needed to be burned to produce a given quantity of the electric and thermal heat. The excessive moisture content decreases the caloric value of the burned fuel. The ash content determines the ash content of exhaust fumes, the ash fall on the grounds and the dust content in the atmosphere as well as the amount of the removed slag. The sulfur content determines the sulfur content in the atmosphere, the content of trace and radioactive elements determines the additional harmfulness of the ash fall on the grounds and the dust content in the atmosphere. The trace elements stay in the fly ash and the slag after the burning of the coal.

The level of the coal consumption in one of the power plant in the southern Poland was studied in this research. The analysis covers 78 periods (consecutive months from July 2002 up to December 2008). The aim of this study was to verify the suitability of selected methods for forecasting of the coal consumption in the first half of 2009. The basic models used for forecasting of the coal consumption included:

1. the model of development trend,
2. the Holt's linear model (the most commonly used model of the forecasting of the short-term demand is the simple model of the exponential smoothing (Brown's model) [Wallström and Segerstedt 2010], the trend and random fluctuations found in the analyzed data were the reasons to use Holt's model),
3. ARIMA model,
4. one equation econometric model,
5. the logit model.

Due to the fact, that all above mentioned methods are described in detail in the literature, including the literature covering the logistics and logistics management [Sarjusz-Wolski 2000, Krzyżaniak 2002], only the most important characteristic of them were presented in this paper.

The model of development trend is a model in which there is a trend and the time variable is the explanatory variable. The time variable determines the influence of unknown factors onto the formation of the level of estimated variable and enables the quantitative analysis of these changes. The linear equation of the trend function was used to describe the level of the coal consumption [Cieslak 2005]:

$$y_t = \alpha + \beta t.$$

The parameter β describes the direction of the development of studied phenomenon, as well as the stable increase of the values of estimated variable in the time unit.

The Holt's linear model is used for smoothing of time series including the trend and random fluctuations. It consists of two equations [Cieślak 2005]:

$$F_{t-1} = \alpha y_{t-1} + (1 - \alpha)(F_{t-2} + S_{t-2})$$
$$S_{t-1} = \beta(F_{t-1} - F_{t-2}) + (1 - \beta)S_{t-2}$$

where: F_{t-1} – smoothed value of forecasted variable at the given moment (period) *t-1*

S_{t-1} – smoothed value of the trend growth at the given moment (period) *t-1*

α, β – model parameters having the value within the interval [0; 1].

The forecast value at the moment (period) $t>n$ is determined by the formula:

$$y_t^* = F_n + (t-n)S_n$$

where: y_t^* – the forecast of the variable Y determined at the moment (period) *t*,

F_n – smoothed value of forecasted variable at the moment (period) *n*,

S_n – smoothed value of trend growth at the moment (period) *n*,

n – the number of points in time series of forecasted variable.

The ARIMA model is a mixed one and consists of the autoregression and the moving average. It can be applied for modeling and forecasting of stationary and non-stationary series, which could be transform to the stationary ones. In practice, most of the time series is of non-stationary nature and because the non-stationary model can be featured by the spurious regression, the stationarity of the series should be examined before the selection of the forecasting method [Gruszczyński 2004]. The process: ARIMA (p, d, q), where *d* is the level of the integration, *p* is the order of the autoregression and *q* is the moving average, could be presented as [Cieślak 2005]:

$$y_t = \varphi^*_1 y_{t-1} + \ldots + \varphi^*_{p+d} y_{t-p-d} + \varepsilon_t - \theta_1 \varepsilon_t - \ldots - \theta_d \varepsilon_{t-q}$$

where: ε_t – forecasting error.

The model of trend estimation, the Holt's linear model as well as ARIMA model are the models of times series. The estimations of the accuracy and relevance of forecasts based on time series are made by [Zeliaś at al. 2004]:

1. the estimation of expected value of empirical deviations of the value of forecasted variable from the determined forecasts (errors *ex ante*),
2. the calculation of expected value of empirical deviations of the value of forecasted variable from the determined forecasts (errors *ex post*).

The one equation econometric model assumes the relationship between the variable explained (y_t) and the explanatory variables (x_{it}) and has a form [Cieślak 2005]:

$$y_t = \sum_{i=0}^{m} \alpha_i x_{it} + \xi_t \qquad t = 1,\ldots,n$$

where: α_i – values of structured parameters

ξ_t – random component.

The estimation of parameters indicates the average change of the value of the dependent variable if the independent variable *i* changes by one unit and when other variables do not change. The verification of the one equation econometric model consists of: the signification of the estimations of parameters, the coefficient of determination, the linearity of the model, the normality of the distribution of residuals, the heteroscedasticity of a random component and the autocorrelation of a random component.

The logit model is an econometric model of zero-one variables. It describes the formation of the random endogenic variables, having the values of zero or one and a form of [Kufel 2011]:

$$y_i^* = \ln \frac{P_i}{1-P_i} = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i$$

where: y_i^* – logit,

P_i – the probability of the dependent variable y_t, determined on the basis of the logistic distribution by the use of the equation:

$$\frac{P_i}{1-P_i} = e^{y_i^*} = e^{\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i}$$

$$\hat{P}_i = \frac{P_i}{1+e^{-y_i^*}} = \frac{1}{1+e^{-(\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij})}}$$

The marginal effect for the variables is significant in the logit model, which is the estimation of first derivative of the average and indicates the direction – the slope change of the probability of a given variable. The estimated marginal effects indicate that:

- the growth of the value of a given variable increases the probability that the variable has a value 1, if the marginal effect is positive,
- the decline of the value of a given variable increases the probability that the variable has a value 1, if the marginal effect is negative.

The significance of factors used as the explanatory variables in the model is tested by the use of *t*-student test. It is also possible to use in the verification process as follows (the measures of fitting for a model of quality variables are described in detail by Maddala [2006]):

- number of cases of the corrected prediction, i.e. the estimated coefficient of the determination R^2, which allows to estimate generally the degree of the model fitting to the date based on the sample used to create a model – in other words, it is a number of cases, for which the model correctly determined the forecasted value,
- McFadden's pseudo R-squared, which is the measure of R^2 type (although it has no equivalent in other R^2 defined for linear regression),
- the probability ratio test, i.e. the test of significant of the estimated equation (if *p* is less than the assumed level of the significance, than there is the significance of the whole regression),
- the coefficient of correlation, which is described as the correlation of variable y_i with theoretical values of the model $\hat{P}_i$, i.e. $R = r(y_i, \hat{P}_i)$.

The described methods were used to create the forecast of the coal consumption. The following assumptions were taken:

1. The time variable is the explanatory variable – a model of development trend,

2. Due to the existence of a small decreasing trend and radon fluctuations, the Holt's linear model was used,
3. The process of the coal consumption is a stochastic process, which could be stationary or non-stationary – ARIMA model *(p, d, q),*
4. The coal consumption depends on the production scale or its parameters – one equation econometric model,
5. The zero-one variable (which is equal to 1, if the decrease of coal consumption occurred simultaneously with the increase of the production and is equal to 0 in other cases) depends on coal parameters – the logit model.

The estimations results for models of time series are presented in the table 2 and for the econometric model in the table 3.

Table 2. The estimations results for models of time series with the dependent variable *coal comsumption*
Tabela 2. Wyniki estymacji modeli szeregów czasowych dla zmiennej *zużycie węgla*

Model	**Estimation of parameter**	**Level of significance *p***
development trend	$\alpha = 152015.614$ $\beta = -407.021$	<0.00001 <0.00001
Holt's	$\alpha = 0.8$ $\beta = 0$	
ARIMA (1, 0, 1)	$\varphi_1 = 0.995519$ $\theta_1 = -0.234807$	<0.00001 0.03267

The linear function was the best-fitted function in case of the model of the development trend (the highest level of the coefficient of the determination was observed for this function). The parameters α and β for the Holt's model were chosen so, that errors *ex post* of the extinct forecast were the lowest ones. The parameters *p, q* and *d* for ARIMA model were chosen on the basis on estimated criteria of the models' selection: AIC, BIC, HQC, previously proving the stationarity of the process of the coal consumption by the appropriate test.

Table 3. The estimations results for econometric models with the dependent variable *coal comsumption*
Tabela 3. Wyniki estymacji modeli ekonometrycznych dla zmiennej zależnej *zużycie węgla*

Model	**Estimation of parameter**	**Level of significance p**
Independent variable of the rate of production of the electricity	$\alpha_0 = 105426$ $\alpha_1 = 4.89911$	<0.00001 0.00002
Dependent variable: combustion value	const: $\alpha_0 = 480629$ combustion value: $\alpha_1 = -16743.2$	0.00002 0.00172
Model	**Estimation of parameter**	**Marginal effect for averages**
logit model	const: $\beta_0 = -17.8830$ combustion value: $\beta_1 = 0.000722553$	3.32958E-05

In case of one equation econometric models, the variables for which the significance of parameters standing around them was proved, were taken as the independent variables. Due to the fact, that the autocorrelation of residuals of first order was observed, the Cochrane'a-Orcutt method was applied.

The model with one independent variable *combustion value* turned out to be the best one in case of the logit model.

The verification of the prognostic process in case of time series were done on the basis of the relative error of the forecast *ex ante* (η_t), calculated by the use of the formula:

$$\eta_t = \frac{v_t}{y_t^*} \quad t \in [n+1,...,T], \text{ where: } v_T = \left[\frac{(T-\bar{t})^2}{\sum_{t=1}^{n}(t-\bar{t})^2} + \frac{1}{n} + 1 \right]^{0,5} \cdot s$$

T – number of the moment or the period, for which the forecast was estimated,

$\bar{t}$ – average value of time variable in time series with *n* observations,

s – residual standard deviation.

The error for used methods was given in the table 4.

The smallest relative errors were observed in case of forecasts calculated by the use of the Holt's linear model, which proves the highest accuracy of the forecasts. The smallest forecasts accuracy was found for ARIMA model. Unfortunately, the estimated errors are significantly higher than 10%, which indicates they cannot be accepted according to generally accepted criteria given in the literature [Zeliaś et al. 2004]. However, due to the character and the importance of the estimated variable, it can be accepted even in case the error is higher than 10%. The recipient of the forecast can take his own criteria for its acceptability. Taking into the consideration a fact, that the amount of the used coal is determined not only by the rate of the production or its parameters but also the technical and technological aspects of the production infrastructure, the criterion of the acceptability of the forecast can be increased.

Table 4. The relative *ex ante* errors of forecasts for time series models
Tabela 4. Względne błędy prognozy *ex ante* dla modeli szeregów czasowych

the period of the empirical verification of the forecast	**forecast error v_t/y_t^***		
	the development trend model	**Holt's model**	**ARIMA (1,0,1)**
t=79	0.158	0.153	0.142
t=80	0.158	0.154	0.179
t=81	0.159	0.155	0.210
t=82	0.160	0.157	0.237
t=83	0.161	0.158	0.262
t=84	0.161	0.159	0.284

The forecasts errors cannot be calculated for estimated econometric models without the previous estimation of values of variables taken as independent ones. Therefore, the verification of the model

was conducted according to measures and statistical tests accepted in the literature. The results of the verification process were presented in the table 5.

Table 5. The results of the verification of econometric model for dependent variable *coal consumption*
Tabela 5. Wyniki weryfikacji modeli ekonometrycznych dla zmiennej zależnej *zużycie węgla*

Model	**results of the verification**
independent variable *rate of the production of the electricity*	residual standard error = 13963.7 coefficient of determination R^2 = 0.547058 corrected coefficient R^2 = 0.541019 statistics of Durbin-Watson test = 2.17146 autocorrelation of residuals of first order = -0.0874121 Test of normality of residual distribution: test statistics: $\chi^2(2)$ = 0.14778 when p = 0.928774
independent variable *combustion value*	residual standard error = 14947.4 coefficient of determination R^2 = 0.480226 corrected coefficient R^2 = 0.473296 statistics of Durbin-Watson test = 2.08418 autocorrelation of residuals of first order = -0.0438203 Test of normality of residual distribution: test statistics: $\chi^2(2)$ = 1.81919 when p = 0.402688
logit model	number of cases of 'correct prediction' = 74 (94.9%) McFadden's pseudo-R-squared = 0.0219796 probability ratio test: Chi-squared (1) = 0.527779 (p = 0.467542)

The verification process confirmed the goodness of one equation econometric model. Therefore, the coal consumption can be forecasted depending on the ratio of the production or its parameters. Only the logit model cannot be considered a good one, since the high value $p>0.1$ in the test of the significance of the estimated equation does not indicate the significance of the whole regression.

SUMMARY AND DISCUSSION

The supply of the power plant in the coal is an important element of logistics, because it is a basic raw material used directly in the production process. Due to the fact, that the share of costs of fuel in material cost in the analyzed plant and periods was within the range from 86.04% to 95.35% and its share in total costs was within the range from 36.61% to 54.27%, the proper management of its purchase guarantees the economics of the logistics process. Therefore, the problem of the estimation of the coal consumption in the production seems to be an important problem especially that the process of the energy production is carried out "on-line", because the energy cannot be stored. The method applied in this study indicate that the calculated forecasts could be useful in the decision making process of the supply system of power plants. The forecasting process can be performed based on the time series models as well as on cause-effect models, depending on whether the explanatory variable showing the level of the coal consumption is: the time variable, the rate of the production or the coal parameters. Unfortunately, the big random variability of the coal consumption in the production process in the power plant is the reason of the big errors of the forecasts. The reasons of the

forecasts errors could be also the form of the available data, which not always allows building a good and correct model. Furthermore, the raw materials used directly in the production process are not the only materials necessary to perform the production process in the power plants. The identification of problems connected with the production process with reference to the forecasting could be an incentive to find new analytical solutions in this area. Therefore the direction of the future researches was formed, particularly including following tasks:

- the influence of the uncertainty and the variability of the demand on the raw materials directly used in the production process on the decisions in the area of the materials management,
- the application of methods for analyzing and forecasting of the discrete demand,
- stochastic approach to the materials planning,
- errors analysis of data used in the analysis.

The proposed methods of the analysis can help to find even better methods of the forecasting, particularly in case of the companies operating in uncertain conditions.

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PROGNOZOWANIE POPYTU NA MATERIAŁY BEZPOŚREDNIO PRODUKCYJNE JAKO ELEMENT LOGISTYKI ZAOPATRZENIA ELEKTROWNI CIEPLNYCH

STRESZCZENIE. W artykule zwrócono uwagę na problemy związane z procesem prognozowania realizowanym w ramach logistyki zaopatrzenia elektrowni cieplnych. W części teoretycznej skoncentrowano się na znaczeniu prognozowania zapasów surowcowych w elektrowniach oraz jakości decyzji logistycznych determinowanych wartością użytkową danych pozyskiwanych, gromadzonych, przetwarzanych i przesyłanych w ramach systemu logistycznego. W części praktycznej zaprezentowano wyniki badań przeprowadzonych w jednej z elektrowni cieplnych Południowej Polski i dotyczących prognozowania popytu na materiały bezpośrednio produkcyjne.

Słowa kluczowe: gospodarka zapasami, wartość użytkowa informacji, prognozowanie, metody prognozowania.

DIE PROGNOSE DER NACHFRAGE DER ROHSTOFFE FÜR DIE PRODUKTION ALS DAS ELEMENT DER BESCHAFFUNGSLOGISTIK VON THERMISCHEN KRAFTWERKEN

ZUSAMMENFASSUNG. Der Artikel unterstreicht die Probleme mit dem Prozess der Prognose innerhalb der Beschaffungslogistik in thermischen Kraftwerken. Der theoretische Teil konzentriert sich auf die Bedeutung der Prognose der Vorräte der Rohstoffen in Kraftwerken und der Qualität der logistischen Entscheidungen, die von den Nutzwert der gewonnenen Daten, gespeichert, verarbeitet und übermittelt innerhalb des logistischen Systems, abhängig sind. Der praktische Teil präsentiert die Ergebnisse von Studien in einem der thermischen Kraftwerke im Süden von Polen und die Ergebnisse der Prognose der Nachfrage für die Rohstoffe, die direkt im Herstellungsprozess verwendet wurden.

Codewörter: Bestandsmanagement, nützliche Wert der Daten, Prognose, Prognoseverfahren.

Agata Mesjasz-Lech
Czestochowa Univeristy of Technology
Faculty of Management
ul. Armii Krajowej 19 B
42-200 Częstochowa
e-mail: agata.mesjasz@poczta.fm

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 3
No 1

http://www.logforum.net

RTLS VS RFID - PARTNERSHIP OR COMPETITION?

Piotr Cyplik[1], Andrzej Patecki[2]

[1)] Poznan School of Logistics, Poznan, Poland, [2)]ASTEC Sp. z o.o, Zielona Góra, Poland

ABSTRACT. The constant technological development entails increasing needs of a precise identification and location of objects. A natural and proved way of fulfilling identification needs is using Optical Character Recognition (OMR, mostly bar codes) or Radio Frequency Identification (RFID). However, applying RFID to locate objects is a big challenge. In applications, which require both identification and location of objects, RTLS (Real-Time Location Systems) can be very helpful. Apart from the identification, RTLS ensures also the real-time objects' location. A range of possible RTLS applications coincides with the ones of RFID. Does that mean that RTLS is a next stage of RFID development? In the following paper, the authors are pursuing to answer a question, if RTLS is complementary or competitive towards RFID?

Key words: RTLS, RFID, objects' location.

INTRODUCTION

The continuous growth of the population and the constant technological development creates the increasing needs for the identification and the location of objects. The necessity of a rapid and efficient identification has become an essential element of a competitive advantage of the supply chain. The emergency of the technology for the automated identification was a milestone in this area.

The automatic identification, known also as AutoID (abbreviation for Automated Identification) or ADC (Automated Data Collection), are systems, which main task is to identify goods, locations, animals and persons without the direct human intervention (e.g. without the entering data into the computer by the use of the keyboard). The name “Automated identification” covers many various techniques and methods, used for the identification process. The best known and the most widely used are [Halas 2000]:

OCR – Optical Character Recognition,

MCR – Magnetic Card Recognition,

OMR – Optical Mark Recognition.

RFID – Radio Frequency Identification.

OCR (Optical Character Recognition) are systems, which rely mainly on a special kind of software, that is designed to recognize individual characters or their series, that occur e.g. in scanned documents. Previously, the systems of this type were fairly primitive and allowed only the identification of printed characters, but thanks to the rapid development of the information technology, the present OCR systems are able to recognize even the handwriting [Halas 2000].

Citation: P.Cyplik, A.Patecki, 2011, RTLS vs RFID - partnership or competition?. LogForum 7, 3, 1
URL: http://www.logforum.net/vol7/issue3/no1
Accepted: 11.06.2011, on-line: 5.08.2011.

The MCR system (Magnetic Card Recognition) is a slightly different technique for the automated identification. The magnetic cards e.g. credit cards or phone cards, are the best examples of the implementation of this technique. The principle of their operation is based on reading the information in magnetic strip, placed mainly on a plastic carrier [Finkenzeller 2003].

The Optical Mark Recognition (OMR) is one of the most recognizable and most frequently used AutoID methods. The OMR method is based on searching and recognizing specially coded tags, which contain information. These systems may be responsible e.g. for scanning of the surveys or voting cards. This method is often found in the identification systems using bar codes [Jones et al. 2004].

The RFID method (Radio Frequency Identification) is last one of mentioned technologies. The RFID method is considered by many experts to be the successor of OMR systems, especially in the area of bar codes applications. Already for a few years, there are implementations of RFID methods, which successfully complete or replace the bar codes methods [Vijayaraman&Barbara 2006].

These four main identification methods are not the only ones, which exist. The other ones, not described above and used more and more commonly are: biometric identification, touch identification, smart chip cards as well as Real-Time Location Systems. The active RFID systems are the closest to RTLS technology regarding the way of action, possibilities and the implementation. The ability of a precise location of the label in the space is the main distinguishing feature of RTLS system, not available in other technologies.

The aim of considerations of this paper is the comparison of possibilities of the implementation of identification methods based on modern technologies such as RFID and RTLS in certain economic conditions. The authors undertake the attempt to answer the question whether the RTLS system is complementary or competitive to the RFID system.

THE ESSENCE AND THE APPLICATION OF SOLUTIONS BASED ON RADIO FREQUENCY IDENTIFICATION (RFID)

RFID (Radio Frequency Identification) is the ADC technique consists in the modulation of a radio signal emitted by the reader (interrogator) by the use of a response signal of data encoded in transponders (tags) and indentifying objects [Halas 2000]. The idea of the necessity of creating the identification system, in which the human interference would be limited to minimum, is not a new one. It emerged already a few decades ago. However, the technological limitations prevented the development of such technology at the time when this idea appeared. Only due to the rapid development of the information and communication technologies in last twenty-five years, it became possible to develop an efficiently working system. Until recently, OMR systems were the only ones, which were close to the ideal automated identification system. Nevertheless, over years, they became no longer sufficient as well as many disadvantages associated with their use, were brought to light. Therefore, there was a need to create a system, having all advantages of bar codes and at the same time eliminating as many their disadvantages as possible. The biggest disadvantages of bar codes system is the emergence of so-called “bottleneck” effect, which originates in technical limitations of previously used systems. It consists in fact, that one scanner can read only one code in the given moment. The strong dependency on human activity is another disadvantage of bar codes. It is a man, who is responsible for scanning the code of a good during the goods’ acceptance and collecting processes in the warehouse. The situation was slightly improved by introducing systems, which automatically scan the codes of products. Unfortunately they also have some disadvantages and can be used only in selected cases e.g. automated sorting of consignments. The above-mentioned disadvantages were eliminated by developing the RFID technology. Additionally many new functions, offered by this system, became available. First of all, due to the implementation of special anti-collision systems, a single reader is able to read up to 200 tags at the same time, which eliminates the “bottleneck” effect. The integration of RFID tags with antivol systems was successful, which eliminates the additional protection, necessary in the case of bar codes systems. RFID allows also tracking goods in real time, and therefore the quick inventory is possibly [Sweeney 2005].

RFID systems, used at present, can be applied as self-reliant identification systems or can supplement systems based on bar codes, mainly due to the fact, that there is still relatively small number of companies using RFID systems. Every RFID identification system needs a few elements to operate properly: a tag, an antenna, a reader and a middleware. The RFID systems are in fact the advanced form of antivol gates, used successfully for fast 50 years. And just as in these systems, in case of RFID system, an object with a tag is detected, when it is within the reach of the gate. In contrast to antivol gates, it is not an alarm, which is started, but the procedure of reading the content of a tag.

Just as it was in case of bar codes, the main task of a tag is to transmit the code, which is only a link to appropriate databases containing the data about goods. However, there are also special tags of significant storage capacity, which are able to hold relatively large amounts of data. The data carried by tags are encoded in most of cases according to standards set by the global RFID standardization organization – EPCglobal. The main EPCglobal's focus is put on the unification and the standardization of formats and interfaces of radio tags, i.e. by Electronic Product Code (EPC), which is sometimes identified with "radio bar code" or "bar code of next generation". It is not too far from the reality, since the same identifiers are written in a GS1 bar code and in an electronic code and whose uniqueness is supervised by the international organization GS1.

The next step of reading information encoded in the tag is to start the proper communication procedure via the special antenna transmitting signals. After reading the encoded information, the reader controls the checksum to verify the correctness of read information. In case it reads correctly, it sends the information to the middleware, whose main task is to mediate between the reader and the appropriate databases, from which data, assigned to a specific code, are collected. The middleware is also responsible for filtrations (e.g. elimination of duplicates), queuing and anti-collision solutions [Sweeney 2005].

The RFID technology is used in many areas of an economy. The most commonly used applications of RFID technology of the serious business importance are presented below. They include:

- logistics,
- pharmacy,
- airports,
- libraries,
- food industry.

The progress of the RFID technology is caused mainly by the logistics. The application of RFID technology allows achieving the highest level of the supervision of goods' flows throughout the supply chain (traceability). The accurate tracing of the path of goods is possible by collecting information in each element of the supply chain from the producer, through wholesalers and distributors up to retailers. It allows optimizing the supply process, to eliminate all errors and shortcomings, such as unjustified retentions of goods, losses and thefts, etc. The information about present locations of specific production batches is extremely essential from the point of view of some industry branches.

The increasing interest in the RFID technology is shown by pharmaceutical companies, not only because of the above-mentioned possibility to withdraw from the market the specific batch of products at the relatively low costs of such operation. The RFID based technology allows counteracting one of the main threats existing on the pharmaceutical market – the introduction of counterfeit medicines.

At present, the widely used technology for the identification of luggage in airports is bar codes. However, the technology of bar codes becomes very unreliable under conditions when the luggage moves with a passenger among various airports all over the world. The bent, fuzzy, damp or dirty labels often cannot be properly read. The efficiency of reading them is 90% at best, and rapidly drops below 85%, when equipment used for this purpose gets older or dirty. The situation is quite different if the radio tags replace the bar codes technology. The efficiency of the system based on RFID in the area of luggage management reaches the level above 99% [Sokolowski 2006].

RFID tags are regarded by librarians as successors of bar codes, traditionally used by them. The application of RFID system speeds effectively the work of a library by combining the activation of antivol RFID label and the registration of book's lending into one operation, even in case of several books at once, what had to be done sequentially in case of using of bar codes readers. The popularity of RFID among librarians is caused mainly by facilitating to conduct the inventory of the library. This operation is very simple and involves systematic moving an antenna of reader/programmer along the shelves. The additional advantage of application of antivol protection is the ability to determine immediately what was stolen in case the reader takes a book and will be not stopped in time by the security [Elmuti&Abebe 2005, Kern 2004].

RFID system are so far the only ones, which can provide the full and easy implementation on a large scale, the control of production and the identification of raw materials in the production process. It is very important for the implementation of a system "from the field – to the table". The attention to health quality of products introduced on the market by companies of the food industry is not a novelty. At the moment of Poland's entry into the European Union, the regulations regarding the safety of products tightened up and companies had to fulfil additional requirements, such as the implementation of HACCP system. However, the date of 1st January 2005 was a breakthrough in the area of food safety, because the Regulation 178/2002 of the European Parliament came into the force since that date. It regulates all matters of the obligation of monitoring and tracing of the movement and the origin of food and feed by all foods operators. Therefore, all participants of the supply chain are responsible for food tracing process and not only producers and distributors, but also the retail chains and shops, which are the last link in this chain [Sokolowski 2006].

RFID has been considered the most important identification tool for the establishment of an effective traceability system [Wang et al. 2006]. RFID tags allow a manufacturer of food items to have an audit trail of moments of the retail unit's life, monitoring correct handling, storage, transportation and delivery. Some tags have also the capability to monitor temperature-controlled product on a per unit basis, hence allowing manufacturers to find out exactly where a temperature abuse occurred [Kumar & Budin, 2006].

The comparison of applications of Hazard Analysis and Critical Control Points (HACCP) on one hand, and RFID tracking on the other, for the purpose of reduction of recalls and the subsequent impact in the processed-food industry shows [Kumar & Budin, 2006] that:

- the long history, long-time understanding among experts, the prevention of the food contamination by identifying potential hazard in the food processing chain are strengths of the HACCP; while being most advanced technology, an ability to track units of sale to the cash register and product traceability being those of RFID,
- the perception of being bureaucratic and frequent misunderstanding are the weaknesses of HACCP; while the facts that microorganisms take time to manifest themselves, and that in-plant control capabilities not as clear apply in case of RFID,
- the potential for the further improvement, and re-training of workers are opportunities existing in HACCP; while the potential to change the retail practice, and direct consumer tracking in the event of an emergency in the case of RFID,
- eventual obsolescence in the wake of an improved technology is a threat to HACCP; while system crashes, risk of hacking and loss of data are threats to RFID.

Hecker [2006], on the other hand, argues that RFID promises to solve problems associated with linear bar codes by enabling item-level automatic tracking throughout the supply chain, but this promise has been tempered by accuracy problems, high costs, and environmental limitations when used around metals and liquids. Therefore, he argues, it might be prudent to slow down a bit, until such time, that these issues are fully addressed. This issue is even more important to the food and feed industries as such features are dominant in food and feed items. Another application of RFID technology in traceability is its use in the animal identification. The radio frequency animal identification standard (ISO 11784/85) is a well-tested [IDEA Project Team, 2001] application where animals are tagged and identified automatically, as required. The frequency of standard operation is

134.2 kHz [Kampers et al., 1999], owing the low absorption rate, high penetration depth in non-metallic materials and water at this frequency [Finkenzeller, 2003]. The tag may be attached to the animal in one of three modes, namely ear tags, the subcutaneous injection, or ruminal bolus (only applicable to ruminants). The bolus has been identified as the best tamper proof animal identification tag (99% retention rate, and 100% recovery rate) provided it is implanted at the right age and weight of animals [IDEA Project Team 2001, Fallon et al. 2002, Ayalew et al. 2006].

THE ESSENCE AND THE APPLICATION OF SOLUTIONS BASED ON REAL TIME LOCATING SYSTEMS (RTLS)

The idea of RTLS systems is based on the possibility to determine the location of objects in the space. This operation takes place so quickly comparing to supervised processes, that one can talk about the position's location in real time. RTLS systems may operate based on various physical phenomena but at present the radio system are the dominant ones. Two main trends can be distinguished among them: based on the pattern of the radio waves propagation in the supervised areas (fingerprint) and on the analysis of parameters of radio waves propagation emitted by the label. The second type of RTLS systems are the most often used – based on active tags. The idea of the operation of systems with active tags is based on physical characteristics of the radio wave propagation, which cover the distance from the transmitter to the receiver in the shortest way and with a specific speed. The receiver, called also a sensor, receives the signals emitted by a tag with the help of an array antenna. The processing of received signals allows determining the angle of propagation of the signal, i.e. the angle at which the tag is seen by the sensor. It is so called a method of an analysis of the angle of the signal's propagation (AoA – Angle of Arrival). Another approach is an analysis of time differences of signal's propagations (TDoA – Time-Difference-of-Arrival) - two or more sensors determine time differences of the moment of receiving the tag's signal. The analysis of this information allows determining the location of a tag in the space. The best RTLS systems allow simultaneous use of both types of the signals' analysis.

The industrial environments are generally difficult ones for the propagation of radio waves, due to reflections, interferences and the signal attenuation occurring in them. The variability of these parameters over time should also be taken into account. These requirements cause that radio RTLS use short-term, ultra-wideband radio impulses (UWB). On the one hand, these signals are difficult to be interferenced; on the other hand, they allow relatively easy detection and elimination of reflected signals.

Similarly as in the case of RFID systems, the identificator is contained in the signal emitted by the tag, which allows its unambiguous identification. The identification properties of the RTLS system are similar to those, offered by active RFID systems. In contrast to RFID allowing the localization in control points, RTLS allows the continuous localization of tags in 3D space with an accuracy of up to 15 cm in supervised areas. It enables to realize the business scenarios, which are practically inaccessible by the use of other technologies. RTLS allows realizing the full identification and traceability in the company. In case of above-mentioned pharmaceutical companies, it makes possible not only to analyze the products flow on the level of control points but wherever it is significant. It allows determining, which raw materials had contact with each other during the production process. Therefore, it reduces the possibility of errors. In conjunction with measuring devices installed in a company, it is possible to determine, whether the products remained only in areas, where the required environmental conditions were hold. The staff, having a potential contact with products, can be also included in the process of traceability.

The first RTLS systems appeared in 1998 year. Due to the high price, they were used only in the military and government agencies. The technological progress enabled to reduce the price and RTLS systems were started to be used for industry purposes. Still this technology is hardly known and little used. The automobile industry is a typical example of the application of RTLS. The personalization of the production process, which transforms from the mass production to the make-to-order production, is a big challenge of the technological and logistic nature. The BMW production plant in Regensburg

could be an example, where cars of three various series are produced on the same line and the total daily number of produced cars is about one thousand [Swedberg 2009]. The application of RTLS eliminated the necessity of scanning of bar codes, in order to properly program the tools. At present, the whole process is an automated one. It is enough to bring a tool near the just mounted car. The strength of this solution could be seen in the fact, that the company Atlas Copco offers tools integrated with RTLS as standard ones. Their sophistication allows not only to program tools but also to provide feedback to the system, and thus supervising the correctness of the assembly, e.g. checking, whether a proper bolt or a required washer was used, etc.

In case of BMW, the full and actual visualization of the production process is the benefit of the implementation of RTLS system. RTLS can play an important role in the improvement of the work of hubs, regardless of whether the incoming goods are marked with bar codes or RFID. The benefit could be the security of extremely valuable items, which movement can be monitored by the camera system, controlled by RTLS. The human factor in the handling processes cannot be totally eliminated but it could be minimized. The RTLS tag, installed on the forklift provides information not only about moved goods, but also about the characteristics of the forklift's work. It allows eliminating dangerous behaviours e.g. speeding, work under the influence of intoxicants or not keeping the safe distances between forklifts. The prevention of collisions between forklifts and the staff could be the main task, which would contribute to a significant increase in the safety.

The diagnosis and then the optimization of logistic and production processes is another application of RTLS technology. This application of RTLS allows seeing the real flow of goods, raw materials and staff within an operating company without any interference in the processes. What is only necessary is to install RTLS system and label all significant objects and then it is possible to collect information about their movements, mutual relations and to correlate them with business events. Once the information is gathered, they can be used for the deep analysis of the company, which is the basis for the optimization of processes. The flexibility and quick adaptation to changes are the important elements of modern industry. RTLS systems help to face these challenges. The once installed RTLS system can be freely configurated and adapted to changing needs without the necessity of physical changes in the infrastructure. The defining of zones, checkpoints, required dependencies could be done on the level of the software. Another important use of RTLS system is its application for the localization of individual animals in big herds in the area of large-scale livestock farms. The knowledge of animals' location allows their observation and decreases the costs associated with supervision and searching of individual animals.

RTLS system used in Danish dairy farms, apart from the localization of specific cows in the herd, allows diagnosing the first symptoms of possible diseases. The dedicated software allows the visualization of the movement and the behaviour of animals, which makes easier e.g. to detect the beginning of the ovulation of females and thus to plan the insemination. The analysis of data obtained from RTLS system is more effective than the estimation of reproductive cycle of animals based on a calendar. Moreover, the integration of RTLS with the application CowDetect of SmarterFarming Company helps to optimize the process of milking cows by the exact localization of animals, which have not been recently milked. The above-presented applications of RTLS systems do not cover all possibilities of the exploration of this system in the industry.

In the addition to typical industrial applications, RTLS systems are used also in security and entertainment industry. However, these applications are outside the scope of this paper.

THE COMPARISON OF THE TECHNOLOGY OF AUTO-IDENTIFICATION SYSTEMS: OMR, RFID AND RTLS

Auto-identification systems are constructed according to similar principles and consist of similar elements. There are both many similarities but also significant differences among OMR, RFID and RTLS systems. Table 1 presents this comparison.

Table 1. Comparison of bar codes to RFID tags
Tabela 1. Porównanie kodów kreskowych do etykiet RFID

Characteristics	Bar codes (OMR)	RFID passive	RFID active	RTLS (based on UWB)
Content modification	lack	available	available	lack
Protection	weak	from weak to good	very good	very good
Capacity	8-30 characters	up to 64KB	up to 8MB	-
Weight	0	small	average	average 8-25g
Costs	low, below 1 cent	average, below 10 cents	high, up to 100$	high, app. 50$
Standards	steady	evolving	evolving	evolving
Power supply	lack	lack	battery	battery
Life length	short	infinite	3 to 5 years	3 to 7 years
Distance from reader	eyeshot of scanner max 150 cm	up to 15 m	up to 100 m	up to 70 m
Accuracy of localization	-	15 m (within operation field of reader)	100 m (within operation field of reader)	15 cm
Obstacles in reading	everything, which can blocked the eyeshot of a scanner	fields disturbing the radio waves	strong signal, difficult to be disturbed	UWB difficult to be disturbed

Source: own work based on Sweeney [2005], www.zebra.com [2011], www.ubisense.net [2011]

There are many technologies on the market, which enable the identification, indispensable for the realization of the supply chain and production processes: starting from the simplest ones, based on optical reading of graphic symbols (OMR), through the radio identification systems (RFID) and ending with RTLS systems. In terms of the functionality, each consecutive technology eliminates the disadvantages of its predecessor and extends its functionality.

RFID systems have reduced the significance of human factor in the identification process increasing the reliability of the identification process. The susceptibility of labels to damages has decreased significantly. The simultaneous identification of many labels became possible. Additionally, there is a possibility to modify the information written in tags. RFID systems enabled the efficient localization at the level of checkpoints. In case of active RFID, the memory capacity and the reading distance have increased significantly. Finally, RTLS systems, which offer not only effective identification, but also full localization possibilities, both in open space as well as in buildings and especially in difficult industrial environments. So, will RTLS overtake other methods of the identification? RTLS tags are relatively large; therefore, small objects cannot be labelled with them. They are also expensive, therefore they are not suitable to label mass products, and additionally there is a need to take care of their retrieval. Their utilization is forced by the use of electronic part and battery as a power supply, even if their cost is very small in comparison to labelled goods. On the surface, these features restrict the use of RTLS to obvious ones – big products of high values or

situations, where there is a necessity to determine precisely the localization of objects or their mutual localization, especially in the conditions of the changing configuration of work environment, ensuring the safety, etc.

Maybe instead of rivalry, it is better to put focus on their cooperation. In case of a plant using bar codes, it is necessary only to equip the bar codes readers in the RTLS tags. In this way, each reading will be automatically marked spatially. In case of the use of RFID, the means of their transport can be included in RTLS system and equipped in RFID readers. The suitable computer system will combine readings of RFID readers with localization data from RTLS tags and determine correctly the position of objects marked only by RFID tags. In this way, some kind of virtual RTLS tags will be created, based on the cooperation of RFID and RTLS. Additionally, the high configurability of the work environment will be received, where all kinds of spatial configurations will take place in virtual space of information system, without the necessity of moving gates or RFID readers. And it seems to be a way, both technologies should follow, where the mutual cooperation is more beneficial in comparison to possibilities offered by the application of only one of them.

The very wide spectrum of the use of RTLS system is another factor, which persuades to regard the implementation of this system. RTLS system applied in the warehouse to optimize the work of forklifts can be used to create an anti-collision system. The system, which delivers semi-products to work cells, can be the base to create a system of supervision of the production process.

The range of the applications of RTLS system is similar to those of RFID systems. Under certain conditions, there are some indications to use only one of mentioned technologies (considerations concerning the determination of clear criteria for the selection of one of these technologies will be the next step of Authors' researches). There are also examples of parallel use of various technologies of the products' identification, which can be found in the practice. Such an example can be one of German forwarding company, which installed RTLS in its distribution centre, with an area of 13 500 m^2 and 3 000 loads handled per day. Previously, the company had significantly high costs of searching individual items or transport of incomplete loads. Due to that, it decided to implement RTLS system connected with the video monitoring. There are now almost 20 forklifts and 140 gates monitored by 160 cameras. Additionally, there are 30 bar codes scanners, equipped in RTLS tags. The system enables to locate these tags, and therefore scanners. It is possible to locate the items by knowing a position of a reader at the moment of reading, which simplifies the work of the monitoring system.

CONCLUSIONS

The aim of the considerations of this paper was to compare the possibilities of applications of identification methods based on RFID and RTLS in certain economic conditions. Numerous presented examples of possibilities of using both technologies demonstrate broad possibilities for their applications. Many cases prove the complementarity of described solutions, although in some respects they are competitive to each other. Therefore, finding the answer to the question, whether RTLS system is complementary or competite to RFID system, remains a matter of a future.

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RTLS VS RFID - PARTNERSTWO CZY RYWALIZACJA?

STRESZCZENIE. Nieustanny rozwój technologiczny rodzi coraz większe potrzeby związane z identyfikacją i lokalizacją obiektów. Naturalnym i sprawdzonym sposobem zaspokajania potrzeb identyfikacyjnych jest wykorzystanie technologii wizyjnej detekcji znaków OMR (najczęściej kodów kreskowych) lub identyfikacji radiowej (RFID). Jednak użycie RFID do określania lokalizacji obiektów stanowi już duże wyzwanie. W aplikacjach, w których jednocześnie wymagana jest identyfikacja i określanie położenia obiektów znajdują zastosowanie systemy RTLS (Systemy Lokalizacji Czasu Rzeczywistego). Systemy RTLS oprócz identyfikacji zapewniają precyzyjną lokalizację obiektów w czasie rzeczywistym.

Paleta zastosowań RTLS jest zbieżna z zastosowaniami RFID. Czy w takim razie RTLS stanowi kolejny etap rozwoju idei RFID? Na łamach poniższego artykułu autorzy podejmują próbę odpowiedzi na pytanie, czy system RTLS jest komplementarny czy konkurencyjny względem technologii RFID?

Słowa kluczowe: RTLS, RFID, identyfikacja położenia obiektów.

RTLS VS RFID – PARTNERSCHAFT ODER KONKURRENZ

ZUSAMMENFASSUNG. Die ständige technologische Entwicklung bringt dem zunehmenden Bedarf für die Identifizierung und die Lokalisierung von Objekten. Die Methoden von der optischen Zeichenerkennung oder der Identifizierung mit Hilfe elektromagnetischer Wellen (RFID) sind die natürliche und geprüfte Methode für die Identifizierung. Allerdings, die Bestimmung von den Objekten-Positionen ist eine große Herausforderung. In Anwendungen, in denen zur gleichen Zeit die Identifizierung und die die Bestimmung von den Objekten-Positionen erforderlich sind, werden RTLS-Systeme (Echtzeit-Lokalisierung) verwendet. RTLS-Systeme ermöglichen zusammen mit der Identifizierung auch die genaue Lokalisierung von Objekten in der Echtzeit. Der Bereich der möglichen Anwendungen von RTSL ist sehr ähnlich den Anwendungen von RFID. In solchen Fall, ist RTLS die nächste Etappe der Entwicklung der Idee von RFID? In dieser Arbeit versuchen die Autoren diese Frage zu beantworten: ist RTLS eine Ergänzung oder eine Konkurrenz für RFID?

Codewörter: RTLS, RFID, Identifizierung der Lokalisierung von Objekten.

doc. dr inż. Piotr Cyplik
Wyższa Szkoła Logistyki w Poznaniu
ul. Estkowskiego 6,
61-755 Poznań
e-mail: piotr.cyplik@put.poznan.pl

mgr inż. Andrzej Patecki
ASTEC Sp. z o.o.
ul. Piaskowa 14
PL 65-209 Zielona Góra

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 3
No 2

http://www.logforum.net

SIMPLE, COST EFFECTIVE & RESULT ORIENTED FRAMEWORK FOR SUPPLIER PERFORMANCE MEASUREMENT IN SPORTS GOODS MANUFACTURING INDUSTRY

S Parkash[1], Veerender Kumar Kaushik[2]

1) Singhania University, Rajasthan, India 2) Technological Institute of Textile & Sciences, Bhiwani, Haryana, India

ABSTRACT. The emergences of global markets have increased competition worldwide. For the Sports Goods Manufacturing Industry which is considered to be an intensive supplier base industry with limited resources to sustain in what is already a very competitive market there is a need for the entire supply chain viz. raw material and machinery suppliers and manufacturers to measure their supplier's performance to reduce business risks and revenue losses. How to design & execute a simple, cost effective & result oriented Framework for Supplier Performance Measurement for sports goods manufacturing small - medium enterprises is the main aim of this research paper.

Key words: Supplier Performance Measurement, Supply Chain, the Weighted Point Model, Sports Goods Manufacturing Industry, ISO 9001.

INTRODUCTION

"In today's competitive environment it is impossible to successfully produce high quality, low cost products without considering a satisfactory set of suppliers."[Soukoup 1987] The Sports Goods Manufacturing Industry involves several types of suppliers ranging from general utilities, PU, PVC, Padding Material, Cork Wood, Cotton & Polyester, Latex & Rubber, Non Woven Fabric, Bonding Agents, Bladders, Screen printing Inks, Stitching Threads, Machinery for Stitching, cutting etc. to large plant equipments. In case suppliers to the end manufacturer of sporting goods do not perform as agreed upon, it will first of all have an impact on the whole supply chain because the supplier is the first link in this chain. Thus, the end product will be negatively affected as well. Consequently, an end product can only be as good as the parts it is made of. In this context, the buyer's products or services are heavily dependent on his suppliers' performances. "However, without careful monitoring of supplier performance, a firm is unable to accurately assess whether its current suppliers are meeting the needs of the firm, and suppliers are unable to respond to unexpressed partner needs."[Simpson et al. 2002] A supplier performance expectation can be defined as "a specific statement of a business practice, process, policy and/or the results anticipated or required from a supplier's performance or behavior in relation to the customer".[Gordon, Sherry 2008]

Supplier Performance Measurement is process of choosing desired performance measures and generating a combined measurement of these. After a quick view to the questions "what is supplier performance measurement?" and "why to measure the supplier performance?" another important question can be stated as "how to measure the supplier performance?"

Citation: Parkash S., Kaushik V.K., 2011, Simple, Cost effective & Result oriented Framework for Supplier Performance Measurement in Sports Goods Manufacturing Industry. LogForum 7, 3, 2
URL: http://www.logforum.net/vol7/issue3/no2
Accepted: 11.05.2011, on-line: 5.07.2011.

In this pursuit, the author having worked as Head Of Materials Department in one of the reputed Sports Goods Industry with in India for more than 12 years selected this as a single exploratory case study to find out what the industry expect from suppliers and if suppliers are efficient to fulfill industry requirements.

This paper is composed of five sections. In the following section supplier performance measurement is overviewed with its basic concepts, and then measurement methods used in the paper are explained based on literature review. The third & fourth section focuses on the methodology explaining the way of WPM application with using ISO 9001; 2008 QMS standards and example showing its results. In the final section, the results are discussed and commented.

LITERATURE REVIEW

World-class competition, criticality of product / marketing timing, escalating customer demands & the tremendous emphasis on quality are but a few of the key challenges confronting most sports goods manufacturing industries today. "These developments in turn, have had a monumental impact on the purchasing function in most organizations. Now purchasing has expanded to become supply management. Often included in this expanded responsibility is the integration of long - term strategic materials planning with the corporate strategic planning process. This approach inherently recognizes the pivotal role played by suppliers. They are the key to successful execution of the buying firm's plans. Purchasing emerging role -proactive & more strategically oriented - focuses the management of subsequent supplier relations & performance, with an emphasis on quality." [Dobler et al. 2002] "Supply Management is a process responsible for the development & management of a firm's total supply system - focuses heavily on the strategic aspects of the key elements of a firm's supply system." [Dobler, Burt 2002] A key and perhaps the most important process of the supply management is the efficient performance of suppliers, because it brings significant savings for the organization e.g. reduce risk and maximize the total value for the buyer. Suppliers are key value supply chain participants. "Supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer & suppliers, but also transporters, warehouses, retailers & customer themselves." [Chopral, Meindl 2001] As noted by fine, "supply chains are the next source of competitive advantage" [Fine 1999] Suppliers have varied strengths and weaknesses. It is very difficult for supplier to excel in all dimensions of performance. But these have to satisfy minimum overall performance standards.

Supplier performance measurement (SPM) is a mechanism to track supplier progress towards meeting organizational goals, & gives feedback to the supplier base on their individual performance. "Good supplier performance is a key ingredient in enabling firms to achieve business performance excellence. But how can firms manage or even influence the performance of outside suppliers? Supplier performance management (SPM) is being widely adopted as a method to understand and improve the performance of the extended enterprise." [Gordon Sherry R. 2010]

Basis: It is built through effective communication, & clearly defined objectives. It includes critical processes to define measure and analyze supplier performance to meet business goals. Create & maintain performance targets that can be defined & monitored, to ensure that our supply base understands that quality & delivery levels to meet our customer satisfaction goals.

A Perfect SPM program should:

- Align with objectives of the firm, not be focused only on Procurement
- Planned and designed with those corporate goals in mind - not just "happen"
- Measure and monitor progress against a plan based on supplier performance measures
- Undergo scheduled reviews and improvement processes.

Main Elements

A supplier performance evaluation has four primary areas:

- Factor & Criteria
- Weighting
- Rating Scale
- Ease of Use and Effectiveness in providing data for decision-making
- Share results with suppliers and stakeholders
- Review and recalibrate performance measures periodically

A company should select performance measures that best represent the criteria that lead to improved customer, operational and financial performance. "Firms should concentrate on strategic suppliers who are integrated business partners as well as core suppliers, who require integration and development plus other suppliers that may supply a high-cost or high-risk item." [Barrett, Rizza 2008]

The following seven steps comprise a process for developing and deploying supplier assessment:

1. Align supplier performance goals with organizational goals and objectives.
2. Determine an evaluation approach.
3. Develop a method to collect information about suppliers.
4. Design and develop a robust assessment system.
5. Deploy a supplier performance assessment system.
6. Give feedback to suppliers on their performance.
7. Produce results from measuring supplier performance. [Gordon 2010]

The Development of the supplier evaluation model

In literature, there exist a lot of contribution in the form of practice and models for evaluating and measuring supplier performance [Tan et al., 1999; Neely, 1999; Anderson and Lee, 1999; Tracey and Tan, 2001; Çebi and Bayaktar, 2003; Gunasekaran et al., 2004].

Organisations that perform well tend to place less importance on unit price than on selection and evaluation criteria; they select and evaluate suppliers on the basis of good quality, delivery reliability and product performance [Gunasekaran et al., 2004]. They also involve their key suppliers in the decision-making process and successfully involve them in continuous improvement programmes [Tracey and Tan, 2001]. Percin [2006] states that the analytic hierarchy process (AHP), introduced by Saaty [1977], is a theory of measurement that provides the ability to incorporate both qualitative and quantitative factors in the decision making process. Sarode et al. [2008] reported total twelve measures which includes qualitative and quantitative type-quality, visibility, flexibility and responsiveness, resource utilization, cost, asset, technological capability, service and time to market apart from these twelve measure total fifty eight items/ variables identified.

Several formal methods for supplier performance evaluation have appeared in the literature, such as the categorical method, weighted point method, cost ratio method [Dobler, Lee, Burt 1990, Leenders, Fearon, England 1981, Timmerman, 1986, Zenz, 1987], and analytic hierarchic process (AHP) [Narasimhan, 1983] etc. These systems differ in ease of use, level of decision subjectivity, required resources to use the system and implementation costs. Although each of these approaches offers advantages under specific conditions, none provides a general methodology for combining multiple criteria or attributes into a single measure of supplier performance. The model developed in this study is the adoption of the weight-point method along with ISO 9001 QMS Standards. It proposes the sports goods manufacturing industry a simple, flexible, cost effective and result oriented framework for evaluation of their supplier's performance.

Some recent supplier performance evaluation and selection studies in various industries are, Baby Food Manufacturing Industry, Weber [1996]; Agricultural and Construction Equipment Industry, Liu et al. [2000], Telecommunications Industry, Narasimhan et al. [2001]; Wooden Furniture Industry, Yahya and .Kingsman [1999]; Food Manufacturing Industry, Çebi and Bayraktar [2004]; retail industry (Wagner vd. [1989] etc.). However, to the author's best knowledge, this will be the first study measuring the supplier performance of sports goods manufacturing industry by the use of Weighted Point Method (WPM) supported with ISO 9001; 2008 QMS Standards.

The Weighted Point Method

The Weighted Point Method has been around for more than half a century. Its longevity attests to its continued usefulness. In the weighted-point method, the relevant attributes are chosen and each are assigned a weight depending on the importance to the overall performance. The firm reaches a consensus on weight assignments to prevent or minimize subjectivity. The weight for each performance category is then multiplied by the performance score that is assigned to it. Finally, these products are totalled to determine a final rating for each supplier. It is highly reliable and its implementation costs are moderate. In addition, it combines qualitative and quantitative performance factors into a common system. Because users can change the weights assigned to each performance category, or change the performance categories themselves depending on the strategic priorities of the firm, the system is flexible.

ISO 9001 Standards

ISO 9001 is an international standard that gives requirements for an organization's quality management system (QMS). These have modifications in the purchasing section as presented in the following clauses.

1. Purchasing

Purchasing Control (ISO9001, Clause 4.6)

Is there a system for assessing sub contractors & vendors?

Do you have a documented procedure for evaluating sub contractors & vendors [Lal 1996]

The organization shall ensure that purchased product conforms to specified requirements. The type and extent of control applied to the supplier and the product shall be dependent upon the impact of the purchased product on subsequent product realization or the final product. The organization shall measure supplier performance based on their ability to supply product in accordance with the organization's requirements. Criteria for performance appraisal shall be established. The results of performance appraisal and subsequent follow-up actions shall be recorded.

Purchasing information

Purchasing information shall describe the product to be purchased, including where appropriate:

A. Requirements for approval of product, procedures, processes, facilities and equipment

B. Requirements for qualification of personnel

C. Quality management system requirements.

The organization shall ensure the adequacy of specified requirements prior to their communication to the supplier.

Verification of purchased product

The organization shall establish and implement the inspection or other activities necessary for ensuring that purchased product meets specified requirements. Where the organization or its customer

intends to perform verification activities at the supplier's premises, the organization shall specify the required verification arrangements and method of product release in the purchasing information.

2. Analysis of data

The organization shall determine, collect and analyze appropriate data to determine the suitability and effectiveness of the quality management system and to evaluate where improvements of the quality management system can be made. This shall include data generated by monitoring and measuring and other relevant sources.

The analysis of data shall provide information relating to:

a) Customer satisfaction;

b) Conformance to product requirements;

c) Characteristics and trends of processes and products including opportunities for preventive action; and

d) Suppliers.

In order to stay compliant with the new ISO 9001 Standards, has to be performed some sort of data analysis on suppliers. The standard gives no suggestions with respect to what to monitor or measure since it is not prescriptive.

ISO 9001:2008 states

In sub clause 0.2 Process Approach: "The application of a system of processes within an organization, together with the identification and interactions of these processes, and their management to produce the desired outcome, can be referred to as the "process approach".

In sub clause 4.1 General requirements: "The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of this International Standard. The organization shall:

a) determine the processes needed for the quality management system and their application throughout the organization (see 1.2),

b) determine the sequence and interaction of these processes,

c) determine criteria and methods needed to ensure that both the operation and control of these processes are effective,

d) ensure the availability of resources and information necessary to support the operation and monitoring of these processes,

e) monitor, measure (where applicable), and analyze these processes, and

f) implement actions necessary to achieve planned results and continual improvement of these processes.

These processes shall be managed by the organization in accordance with the requirements of this International Standard".

Based on the above, each organization should define the number and type of processes needed to fulfill its business objectives. It is permissible for a process that is required by ISO 9001:2008 to be part of a process (or processes) that is already established by the organization, or to be defined by the organization in terms that are different to those in ISO 9001. [Introduction and support package... 2010].

THE METHODOLOGY & EMPIRICAL STUDY

This Research Study has been undertaken as a single exploratory case study with one of the reputed Sports Goods Manufacturing Industry from India for Empirical Examination of framework for Supplier Performance Measurement System by the use of Weighted Point Method (WPM) supported with ISO 9001; 2008 QMS Standards. This research paper Details the business case for supplier performance measurement; where to start; what to measure; how to develop an evaluation process &

How to rank and manage supplier network to get lower operating costs, reduced risk exposure, and more satisfied customers.

Where to start?

Quality Business Process Mapping & establishing Standard Operating Procedures / Working Instructions by use of the "Process Approach" to the ISO 9001:2008 QMS e.g.

A. Purchase Planning & Ordering: Process map is developed & documented for indenting requirements for purchasing, planning & ordering of materials.

B. Supplier Development, Evaluation & Selection: Process map was developed & documented to provide instruction & responsibility for development, evaluation & selection of suppliers.

C. Supplier Performance Monitoring / Re-evaluation: Process map was developed & documented for monitoring the performance of suppliers as per laid down criteria. This process details the steps for quarterly review of supplier performance.

D. Records of the suppliers' performance measurement shall be maintained and kept. The evaluation process would be introduced to the records control process according to paragraph 4.2.4 - control of records.

Whom to measure?

Supplier Selection: All listed supplier which affect quality related to product & job work as discussed with the firms Director Operation

Who will measure?

Organization's purchasing and supply management staff, engineers and quality staff & user will participate in supplier performance measuring program. Here Materials Manager, Purchase Supervisor, Store Keeper & Incoming inspection In charge participate

What to measure?

The performance measures used to determine the degree to which suppliers are performing are selected in consideration with organizational quality policy, objectives & challenges after discussion with the firm's director operation. The following criteria are selected:

- Quality i.e. Receipt Acceptance Rate
- Delivery i.e. On-Time Receipt
- Competitive Pricing
- Proper Responsiveness

How to measure?

The selected performance measures and method of acquiring information have a dependency on one another. Here information regarding "Receipt Acceptance Rate" & "On-Time Receipt" (Being Quantitative in nature) are generated by procurement system itself where receipts and inspections data are recorded. Whereas information about "Competitive Pricing" & "Proper Responsiveness" (Being qualitative in nature) is acquired through the supplier scorecard approach.

"On-Time Receipt"

A procurement system can look at the due dates for each order to a specific supplier and determine which of those orders had receipts against them on or before the due dates and which of those orders had receipts against them after the due dates. E.G. If one receipt arrived on or before the due dates and the other receipt arrived after the due dates, then supplier has an on-time delivery performance of 1 for 2, or 50%

"Receipt Acceptance Rate"

If 10 out of 100 of a supplier's receipts failed incoming inspection, then supplier would have an acceptance rate of 90%.

"Competitive Pricing" & "Proper Responsiveness"

Supplier Scorecard for each of these performance measures is framed. Each scorecard represents a survey of the concerned participant opinion of that supplier's proficiency for the selected performance measures. The scores for each performance measure are based on a scale of 1 to 5 where 1 indicates poor performance and 5 indicate good performance.

Supplier Scorecard Sample

Supplier	How Measured	S - 1
Performance Measure		Score
Provides Competitive Pricing	1 = Poor 5 = Good	
Provides Proper Response	1 = Poor 5 = Good	

Weighted Point Method

The above-acquired information generates concerned performance measure rating which when multiplied by its corresponding criteria weight produce a weighted score for that performance measure. The weighted scores for the individual performance measures are then added to produce a final score of concerned supplier.

How to grade?

The final score for each supplier is computed by summing up all four scores obtained for each performance measure.

Suppliers are ranked from poor performance level to good by creating a list of suppliers & their total scores, then sorting it as per pre determined supplier rating levels. The supplier rating levels are fixed in consideration with organizational quality policy after discussion with the firm's director operation.

Give feedback to suppliers on their performance.

EXAMPLE AND EMPIRICAL RESULTS

For illustration the data set of the 10 main supplier firms from one of the reputed Sports Goods Manufacturing Industry from India (for quarter October to December 2010) in terms of above referred following performance measures, is being given to find & test the empirical results.

Table 1. Data Set of "On-Time Receipt" for the period from Oct. 2010 to Dec., 2010
Tabela 1. Dane dot. terminowości przyjęć za okres październik-grudzień 2010

Supplier	No. of On-Time Receipts	Total No. of receipts	Delivery Performance Ratio
S1	37	47	37/47 = 0.78
S2	42	59	42/59 = 0.71
S3	4	4	4/4 = 1
S4	9	15	9/15 = 0.60
S5	15	18	15/18 = 0.83
S6	9	9	9/9 = 1
S7	32	32	32/32 = 1
S8	20	20	20/20 = 1
S9	3	3	3/3 = 1
S10	11	11	11/11 = 1

Table 2. Data Set of "Receipt Acceptance Rate" for the period from Oct., 2010 to Dec., 2010
Tabela 2. Dane dot. akceptowalności dostaw za okres październik-grudzień 2010

Supplier	No. of Accepted Receipts	Total No. of receipts	Quality Performance Ratio
S1	37	47	37/47 = 0.78
S2	59	59	59/59 = 1
S3	4	4	4/4 = 1
S4	15	15	15/15 = 1
S5	18	18	18/18 = 1
S6	9	9	9/9 = 1
S7	32	32	32/32 = 1
S8	20	20	20/20 = 1
S9	3	3	3/3 = 1
S10	11	11	11/11 = 1

Table 3. Data Set of "Competitive Pricing" for the period from Oct., 2010 to Dec., 2010
Tabela 3. Dane dot. konkurencyjności cenowej za okres październik-grudzień 2010

Supplier	Attained Score	Maximum Score	Competitive Pricing Performance Ratio
S1	9	10	9/10 = 0.90
S2	7	10	7/10 = 0.70
S3	6	10	6/10 = 0.60
S4	6	10	6/10 = 0.60
S5	7	10	7/10 = 0.70
S6	6	10	6/10 = 0.60
S7	7	10	7/10 = 0.70
S8	7	10	7/10 = 0.70
S9	8	10	8/10 = 0.80
S10	6	10	6/10 = 0.60

Table 4. Data Set of "Proper Responsiveness" for the period from Oct., 2010 to Dec., 2010
Tabela 4. Dane dot. „właściwego nastawienia do klienta" za okres październik-grudzień 2010

Supplier	Attained Score	Maximum Score	Proper Responsiveness Performance Ratio
S1	9	10	9/10 = 0.90
S2	7	10	7/10 = 0.70
S3	6	10	6/10 = 0.60
S4	7	10	7/10 = 0.70
S5	7	10	7/10 = 0.70
S6	6	10	6/10 = 0.60
S7	6	10	6/10 = 0.60
S8	8	10	8/10 = 0.80
S9	8	10	8/10 = 0.80
S10	5	10	5/10 = 0.50

SUPPLIER PERFORMANCE RATING BY USE OF THE WEIGHTED POINT METHOD

Criteria	Criteria Weight
Points for Quality Conformance =	40 Points
Points for Receipt Conformance =	40 Points
Points for Competitive Pricing Conformance =	10 Points
Points for Proper Responsiveness Conformance =	10 Points

Supplier Quality Performance Rating/weighted score

Quality Performance Ratio X Criteria Weight

$$Q.P.R = \frac{\text{No. Of Receipts in Quality standard}}{\text{Total No. Of Receipts}}$$

Supplier Delivery Performance Rating/weighted score

Delivery Performance Ratio X Criteria Weight

$$D.P.R = \frac{\text{No. Of Receipts in Schedule}}{\text{Total No. Of Receipts}}$$

Supplier Competitive Pricing Performance Rating/weighted score:

Competitive Pricing Performance Ratio X Criteria Weight

Competitive Pricing Performance Ratio = Attained Score/

Maximum Score

Supplier Proper Responsiveness Performance Rating/weighted score:

Proper Responsiveness Performance Ratio X Criteria Weight

Proper Response Performance Ratio = Attained Score

Maximum Score

Table 5. Quality Performance Rating/Score by use of the Weighted Point Method for the period Oct. - Dec. 2010
Tabela 5. Dane dot. jakości obsługi przy zastosowaniu metody punktów ważonych za okres październik-grudzień 2010

Supplier	Quality Performance Ratio	Criteria Weight	Quality Performance Rating/weighted score
S1	0.78	40	31.20
S2	1	40	40
S3	1	40	40
S4	1	40	40
S5	1	40	40
S6	1	40	40
S7	1	40	40
S8	1	40	40
S9	1	40	40
S10	1	40	40

Table 6. Delivery Performance Rating/Score by use of the Weighted Point Method for the period Oct. - Dec. 2010
Tabela 6. Dane dot. obsługi dostaw przy zastosowaniu metody punktów ważonych za okres październik-grudzień 2010

Supplier	Delivery Performance Ratio	Criteria Weight	Delivery Performance Rating/weighted score
S1	0.78	40	31.20
S2	0.71	40	28.40
S3	1	40	40
S4	0.60	40	24
S5	0.83	40	33.20
S6	1	40	40
S7	1	40	40
S8	1	40	40
S9	1	40	40
S10	1	40	40

Table 7. Competitive Pricing Performance Rating/Score by use of The Weighted Point Method for the period Oct. - Dec. 2010
Tabela 7. Dane dot. konkurencyjności cen przy zastosowaniu metody punktów ważonych za okres październik-grudzień 2010

Supplier	Competitive Pricing Performance Ratio	Criteria Weight	Competitive Pricing Performance Rating/weighted score
S1	0.90	10	9
S2	0.70	10	7
S3	0.60	10	6
S4	0.60	10	6
S5	0.70	10	7
S6	0.60	10	6
S7	0.70	10	7
S8	0.70	10	7
S9	0.80	10	8
S10	0.60	10	6

Table 8. Proper Responsiveness Performance Rating/Score by use of The Weighted Point Method for the period Oct. - Dec. 2010
Tabela 8. Dane dot. „właściwego nastawienia do klienta" przy zastosowaniu metody punktów ważonych za okres październik-grudzień 2010

Supplier	Proper Responsiveness Performance Ratio	Criteria Weight	Proper Responsiveness Performance Rating/weighted score
S1	0.90	10	9
S2	0.70	10	7
S3	0.60	10	6
S4	0.70	10	7
S5	0.70	10	7
S6	0.60	10	6
S7	0.60	10	6
S8	0.80	10	8
S9	0.80	10	8
S10	0.50	10	5

Supplier Performance Grading System

90 - 100 Points / Percent = Good

80 - 89 Points / Percent = Satisfactory (O.K.)

Below 80 Points/ Percent = Poor (Not O.K.)

Supplier performance will be considered o.k. (At Satisfactory Level) at 80 points/80Percent in total i.e. (DPR + QPR) or more, along with D.P.R. & Q.P.R. ratios must be at least 80 Percent or 40 points individually.

Table 9. Supplier Ranking
Tabela 9. Ranking dostawców

Supplier	Total Rating Score i.e. Quality + Delivery + Competitive Pricing + Proper Responsiveness	Performance Level
S1	31.20+31.20+9+9= 80.40	Satisfactory (O.K.)
S2	40+28.40+7+7= 82.40	Satisfactory (O.K.)
S3	40+40+6+6= 92	Good
S4	40+24+6+7= 77	Poor (Not O.K.)
S5	40+33.20+7+7= 87.20	Satisfactory (O.K.)
S6	40+40+6+6= 92	Good
S7	40+40+7+6= 93	Good
S8	40+40+7+8= 95	Good
S9	40+40+8+8= 96	Good
S10	40+40+6+5= 91	Good

CONCLUSIONS

From the outset, this multi-criteria supplier performance measurement framework had the advantages of simplicity, understandability and ease of implementation. [Aljian 1973] It is highly reliable and its implementation costs are moderate. In addition, it combines qualitative and quantitative performance factors into a common system. Because users can change the weights assigned to each performance category, or change the performance categories themselves depending on the strategic priorities of the firm, the system is flexible. Beginning with the 1958 Purchasing Handbook, the weighted point evaluation method (WPEM) was given good grades for its usefulness and effectiveness. [Aljian 1958]

Dobler and Burt state, "The approach is widely used in practice and generally leads to a fair and reasonably objective result." [Dobler, Burt 1996]

This framework will hopefully provide guidance for anyone who wants to develop supplier performance measurement system in sports goods manufacturing industry & other small - medium enterprises.

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PROSTE, EKONOMICZNE ORAZ ZORIENTOWANE NA WYNIK ZASADY OCENY DOSTAWCÓW W PRZEMYŚLE WYTWÓRCZYM SPRZĘTU SPORTOWEGO

STRESZCZENIE. Powstanie rynków o zasięgu globalnym zwiększyło również konkurencję na skalę światową. Przemysł wytwórczy sprzętu sportowego, jako przemysł bardzo zależny od dostawców oraz z ograniczonymi zasobami, aby przetrwać na bardzo konkurencyjnym rynku wymaga sprawnego kompletnego łańcucha dostaw, począwszy od surowców aż do dostawców maszyn jak również systemu oceny tych dostawców w celu redukcji ryzyka związanego z działalnością gospodarczą. Celem tej pracy był system oceny dostawców dla małych i średnich przedsiębiorstw przemysłu wytwórczego sprzętu sportowego, który jest prosty, łatwy w stosowaniu, ekonomiczny oraz zorientowany na wynik.

Słowa kluczowe: ocena dostawców, łańcuch dostaw, metoda punktów ważonych, przemysł wytwórczy sprzętu sportowego, ISO 9001.

EINFACHE, KOSTENGÜNSTIGE UND ERGEBNISORIENTIERTE RAHMEN FÜR DIE BEWERTUNG DER LIEFERANTEN IN DER BRANCHE DER SPORTARTIKELINDUSTRIE

ZUSAMMENFASSUNG. Die Entstehung der globalen Märkte hat den Wettbewerb auf globaler Ebene erhöht. Die Sportartikelindustrie, die sehr abhängig von Lieferanten und mit begrenzen Ressourcen ist, um in sehr wettbewerbsintensiven Markt zu überlegen, erfordert eine komplette Lieferkette vom Rohstoff bis zum Fertigungsmaschinen, wie auch ein Bewertungssystem von Lieferanten, um die Geschäftsrisiken zu reduzieren. Das Ziel dieser Studie war ein Bewertungssystem von Lieferanten für kleinen und mittleren Unternehmen von der Sportartikelindustrie, die einfach, kostengünstig und ergebnisorientiert ist.

Codewörter: Bewertung von Lieferanten, Lieferkette, gewogen Punkt Modell, Sportartikelindustrie, ISO 9001

S. Parkash
Singhania University,
Pacheri Bari, Rajasthan.
e-mail: spk1972@gmail.com
Dr. Veerender Kumar Kaushik
Head Of School Of Management
of the Technological Institute of Textile & Sciences
Bhiwani, Haryana
e-mail: veerenderk_kaushik@rediffmail.com

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 3
No 3

http://www.logforum.net

THE SYSTEMS OF AUTOMATIC WEIGHT CONTROL OF VEHICLES IN THE ROAD AND RAIL TRANSPORT IN POLAND

Bogusz Wiśnicki, Anna Wolnowska

Maritime University of Szczecin, Szczecin, Poland

ABSTRACT. Condition of roads in Poland, despite the on-going modernisation works is still unsatisfactory. One reason is the excessive wear caused by overloaded vehicles. This problem also applies to rail transport, although to a much lesser extent. One solution may be the system of automatic weight control of road and rail vehicles. The article describes the legal and organizational conditions of oversize vehicles inspection in Poland. Characterized current practices weighing road vehicles, based on measurements of static technology. The article includes the description of the existing applications of the automatic dynamic weighing technology, known as systems WIM (Weigh in Motion). Additionally, the weighing technology and construction of weighing stands in road and rail are characterized. The article ends with authors' conclusions indicating the direction and ways of improving the weighing control systems for vehicles.

Key words: road transport, vehicle weighing systems, automatic and dynamic weighing.

INTRODUCTION

The periodic analyses of technical condition of the road and rail infrastructure in Poland indicate the annually increasing maintenance needs. Despite allocating enormous financial means, which come mainly from the EU programmes it, has been unsuccessful to decrease the number of roads and railways needing repair. In the road transport road surface repairs of interventional character are continuous especially where the surface condition directly poses danger to road safety. Planned repairs of periodic character are carried out thereafter, which causes that the line of roads awaiting renovation gets longer and longer. A similar situation is present in the rail transport, though there the lack of finances for renovation and regular maintenance results in closure of a particular railway.

The main reason for the gradual deterioration of the road and rail infrastructure is its operational wear. In the road transport the dynamic increase of means of transport may be taken into account. The growth often exceeds the forecast values of traffic intensity for which a particular road was designed. The operational wear of roads and railways is predictable and directly proportional to the number of assisted means of transport. However, there is a factor which was not considered by designers while scheduling, according to the regulations, subsequent repair periods. It is the additional wear caused by the passage of overloaded means of transport with bigger weight than the permissible one or bigger than the allowed pressure on the axles. A number of such non-standard vehicles which move legally after obtaining an appropriate licence, or illegally without such a licence is very big both in the road and rail transport. This is due to those overloaded rail cars and road trailers that the transport infrastructure undergoes the relevant and abnormal wear in Poland.

Citation: Wiśnicki B., Wolnowska A., 2011, The systems of automatic weight control of vehicles in the road and rail transport in Poland. LogForum 7, 3, 3
URL: http://www.logforum.net/vol7/issue3/no3
Accepted: 11.06.2011, on-line: 5.08.2011.

The statistical data relating to the technical condition of roads in Poland are alarming: 25% of roads require the planned repair and 21% of roads require immediate repair. Research demonstrates that the exceeding of the permissible pressure on the axles brings about a hundred times bigger result of the road surface damage. For example, if the pressure on the axles of about 10% vehicles moving along the examined road were 145 kN instead of the allowed maximum 115 kN, which is in force for selected domestic roads and motorways, the road's life expectancy would be shortened by 25%.

The standard control of loaded means of transport is hampered by its nature. Vehicles are in motion and even random checking requires assistance of many employees from appropriate supervision services. Especially in the road transport the control of a hundred thousand heavy vehicles, which move along all kinds of road beginning with motorways and ending at communal roads, is very limited in practice. Such factors as enormous scattering of subjects offering road transport services, a significant participation of foreign cars, the multi-level management and ownership structure as well as the complicated division of responsibility among the state and local administration bodies do not simplify the task. Such impediments have not affected the rail transport, yet.

The system of automatic control of vehicles must be a solution to these problems. It would be best if the weighing process was carried out in motion without the introduction of restrictions in transport liquidity.

Certainly, a number of questions arises involving technological and economic conditions of such a system. These can be already answered. Moreover, there are outlets of automatic technical inspection of vehicles both in road and in rail transport in Poland. It is worthwhile analysing the examples and possible solutions to evaluate their usability for the future domestic system of vehicle control.

LEGAL REGULATIONS IN THE SCOPE OF VEHICLE TECHNICAL CONTROL

The regulations referring to the process of technical control of wheel and rail vehicles impose obligations on shipping agencies and they grant competences to the infrastructure managers and to a number of outward institutions to make them perform specific actions in this scope. Road and rail carriers are obliged to obey the appropriate regulations referring to the technical inspection of vehicles, the way of distribution and fastening of cargo as well as the organization of non-standard transport. Road and rail administrators should protect the infrastructure from excessive wear though, on one hand, they have restricted control competences and possibility of imposing administrative fines and, on the other hand, they regulate the market of non-standard shipment by granting appropriate permits. Depending on the range of roads the road administrators in Poland include: the General Directorate for National Roads and Motorways (Generalna Dyrekcja Dróg Krajowych i Autostrad - GDDKiA), voivodship governors, poviat and village administrators. The rail infrastructure administrator is the PKP Polish Railway Lines S.A. (PKP Polskie Linie Kolejowe S.A. - PKP PLK S.A.). In Poland security of the road and rail transport is provided by the Police, which is in charge of control of means of transport, cargo as well as drivers or engine drivers. In addition, the Inspection of Road Transport (Inspekcja Transportu Drogowego - ITD) has been established which deals only with supervision of road shipment.

In the road transport legal regulations refer to the so called non-standard vehicles, that is vehicles which exceed the permissible maximum measurements or weight. According to the Road Traffic Act a non-standard vehicle is a vehicle or a group of vehicles whose pressure on the axles with cargo or without it is bigger than the permissible ones envisaged for a given road in the regulations of the act on public roads, or, whose dimensions and weight with cargo or without it are bigger than the permissible ones, envisaged in the regulations on road traffic with exception of buses in the scope of the axle pressure. Polish regulations comply with the EU law in this aspect, especially with the Directive 96/53:

1) maximum permissible vehicle lengths:
   - motor vehicle or trailer - 12,00 m,

- articulated vehicle - 16,50 m,
- road train - 18,75 m;

2) maximum permissible vehicle widths:
   - all vehicles - 2,55 m,
   - superstructures of conditioned vehicles - 2,60 m.
   - maximum permissible vehicle height - 4,00 m.
3) maximum permissible vehicle weights:
   - road trans or articulated vehicles - 40 t,
   - articulated vehicles carrying 40-foot containers - 44 t.

The application of automatic measurement equipment in the road transport causes a number of legal controversies referring to supervisory powers of control bodies, legality of measurement equipment and precision of registered data and the possibility of sanctions on their basis. Most of all legal limitations refer to punishing offenders on the basis of the registered data by the WIM (Weight in Motion) measurement device. Currently, the Police, the Inspection of Road Transport (ITD) and other supervisory bodies can use equipment of this kind in the road traffic on condition that they are authorized. Then they are subject to the legal metrological control which includes validation of the type along with the original legalization and then the relegalizations. The lack of an appropriate legalization or an excessive measuring error for the WIM devices excludes their practical use in the road transport.

In the rail transport non-standard cargo is called special shipment, which means it may cause difficulties in rail carriage and, according to the administrator of the rail infrastructure, it requires special techno-movable conditions due to its:

- shape, dimensions or weight,
- method of loading, distribution and carriage protection,
- used means of transport,
- route of shipment.

The special shipment was defined in the Instructions of PKP PLK S.A., according to which they are among others:

- objects which exceed the determined loading gauge or which are loaded with this gauge's surpass,
- objects where one item weighs over 60 t,
- objects which cause that the load staying on the carriage axle or the current meter of the rail is bigger than the permissible one even at a section of the route,
- specialist rail vehicles e.g. cranes, rail and road machines,
- rail vehicles of exceeded rolling stock,
- objects that require a specialist carriage, equipment, protection or special organization of transport due to the position of the centre of gravity or other reasons related to the safety of carriage,
- objects which require shipment in the hollow floor ,
- rails, steel rods for concrete reinforcement and flexible metals of the length of over 36 m.

In the rail transport the law enforcement body which would be entitled to punish dishonest shipping agencies has not been appointed, yet. In case of failure of meeting conditions of safe carriage only the

units of the Rail Traffic Management and the Rail Traffic Administration Centre are authorized to halt the carriage.

SYSTEMS OF CONTROL IN THE ROAD TRANSPORT

At present the technical inspection of vehicles during shipment requires an appropriate stand equipped with a statistic measuring device making it possible to check such parameters as: total weight, pressure on the axles, length, width and height of a vehicle. Such stands are located by major roads and their construction is prepared to install mobile measurement equipment. Stands of such a type are equipped in stationary measuring devices very rarely. At the beginning of 2010 no more than ten stands located by Polish domestic roads and motorways were equipped with stationary scales for over 120 stands. Unfortunately, often those unsupervised roadside stands are devastated to such extend that they cannot play its function of control. Plans are being made of a considerable increase of control stands, especially on the newly built express roads and motorways.

Stationary scales are often concrete platforms and traps embedded in the ground so that the weighed vehicle is at the same level as the road. Mobile scales are sloping steel constructions or light mats laid out onto a flat surface of the road. A key role in the stationary and mobile scales belongs to piezoelectric and magnetoelastic detectors as well as dial extensometers. The measurement is a static one or a vehicle can move with the maximum speed of 5 km/h. The accuracy of the measurement depends on the applied metrological technology and is up to 0,1%. Due to the electric properties of scales it is possible to connect them to a computer or a printer. As a rule a measurement is conducted by two people, usually the ITD inspectors or the Police functionaries. In the present state of law representatives of the road administrator, e.g. municipal guard services are not entitled to stop cars, which limits their control possibilities.

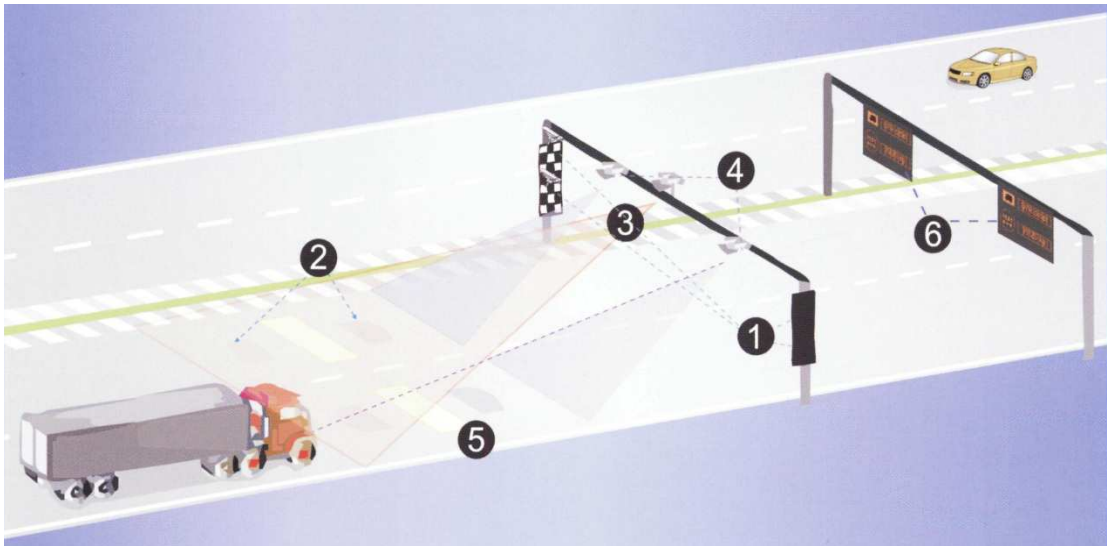
The system of control of vehicles in motion which requires the dynamic measurements is only at the initial stage of construction. At present there are only a few stands for weight preselection and the leader city is Wrocław which has 5 such stands. In order to measure the force of vehicle pressure on the road surface different systems of weighing platforms, piezoelectric or quartz detectors are applied. Platforms or detectors are installed on the road's lane and they enable to measure a vehicle's speed up to 140 km/h. It is significant since such a method of measurement does not hinder the flow of vehicles in the slightest degree. The information on pressure on the axles and the total weight is transferred to the management system. Nowadays it is impossible to execute fines on the basis of measurements conducted in this way because there is a big error involved. External conditions have a big influence on the measurement accuracy and they are: rain, low temperature, wind as well as a vehicle's velocity and acceleration. Producers claim that the scales based on modern quartz detectors exhibit the maximum measuring error at the level of 10% and in Poland the condition to authorize such vehicles is the maximum error at the level of 2% [Doupal E., 2010].

The lack of possibility of penalties execution on the basis of the dynamic measurement caused that scales of this type are used only for vehicle preselection. On the basis of the remote monitoring of the dynamic measurement records vehicles are selected for the specific measurements carried out on the static scales. As a rule, stands for static weighing are located at a distance of nearly a kilometre from the dynamic scales so that it should be possible to effectively stop the selected vehicle. Such a preselecting system works at the tollgates in Wrocław and it effectively protects municipal roads from overloaded vehicles.

The nowadays existing system of weight preselection can be easily extended by adding modules of external measurement of vehicles, that is their length and height. The accuracy of the dynamic measurements is much bigger. The extended preselection system for technical inspection of vehicles in motion comprises the following elements: (fig. 1):

1) camcoder for vehicle height and length measurement,

2) induction loops for connecting/disconnecting of weight detectors (depending on the applied technology)
3) pictorial camcoder,
4) camcoder for recognition of vehicle number plates ,
5) weight platform or detectors ,
6) information boards of changeable contents for drivers.



Source: Neurosoft promotional materials

Fig. 1. The preselection system of vehicles in motion
Rys. 1. System preselekcji pojazdów w ruchu

The passage of every vehicle through the preselective section is registered and then the data are recorded as the XML files. The files include readings from detectors as well as two photographs, from the measurement camcoder and the pictoral camcoder. These data enable to read the vehicle number plates, to determine the make, model and colour, its velocity, length and height as well as the vehicle's top inspection (along with its cargo) [Karp W., 2010]. The system is characterized by a considerable accuracy of readings, for instance, in good light conditions the module for recognition of vehicle number plates correctly recognizes over 95% vehicles. The processed data can be transmitted and presented on monitors of the control services in the real time and they are filed in archives. In this way, the established data base can undergo a statistical analysis in the scope of, among others: intensity and the average velocity of traffic depending on time and type of vehicle, the structure of transit and local motion with respect to time. As of today, data from several points of vehicle preselection are transmitted to the GDDKiA and the ITD servers.

Nowadays in Poland it is impossible to execute penalties automatically on the basis of the systems measuring in motion. There is a barrier of quite a big error of the measuring equipment in the scope of reading of pressures on the road surface. However, this error was accepted by legislation in the Czech Republic where the WIM systems will be a basis for imposing administrative penalties as early as 2010. In fact, the road administrators and the Police of the country fear that numerous appeals will be lodged by drivers, which will undermine reliability of measurements due to the weather conditions of the surface condition. Aware of the fact that accuracy of the measurement deteriorates dramatically while braking or accelerating drivers may deliberately affect the measurement quality. Therefore, there is an opportunity for the Government and the public opinion in Poland to watch effectiveness of the application of the new measuring equipment and execution of penalties at our neighbour's in the South in order to draw suitable conclusions. The undoubted virtues of the systems of automatic control of

vehicles in motion which are measurement continuity, great possibility of analysis of the collected data, reliability of the system, relatively low costs due to the elimination of personal costs, immense prevention significance must be adjusted to legislative restrictions.

THE SYSTEMS OF CONTROL IN THE RAIL TRANSPORT

Along with the increase of the number of rail stock owners, there is a bigger need for control of overload of such transport particularly of the contact pressure between the wheel and the rail. The current data collection on the line and axle overload and on the speed control of vehicles is to ensure safety of this kind of transport but also allows for detection of the above mentioned parameters. As a result, it allows obtaining a real picture of the infrastructure condition and the transport limitations involved.

Relatively recently the safety of rail carriage referred to the load of rails only as long as it helped to determine the pressure on the axle or the vehicle weight. At present it seems to be crucial to detect ovality in the wheels of rail vehicles with relation to the velocities which are used by rail carriers or they would like to move with.

The systems for identification of dynamic load in the rail transport have long been the object of interest and they indicate the need for collection of more and more reliable data in conditions which will restrict transport the least.

Initially, in the road transport there were only bridge structures where extensometers or light pipe detectors were used for measurement. They are mounted inside the bridge structure during its construction or they are installed outside [Chatterjee P. and others 2006, Karoumi R. and others 2005]. Examples of such a type of measuring equipment are rail scales made with the use of prefabricated concrete elements like a platform or a foundation tank (fig. 3). The weighing electronic engineering of rail static scales, dynamic scales and static-dynamic scales consists of extensometers inserted into special elastomer beds as well as control electronics which uses specialist weighing PC software.

Fig. 2. The platform scales (top left), in the foundation tank (top right) and in the rail beams (bottom)
Rys. 2. Wagi kolejowe pomostowe (u góry z lewej), w wannie fundamentowej (u góry z prawej) i w podkładach kolejowych (u dołu)

The latest technological solution in the scope of weight control of rail carriages is scales which use concrete ground beams with embedded extensometers.

The scales do not require foundation since the weighing beams are positioned directly on the ground of stabilized breakstone. Moreover, as the producer claims," a rail in the control zone must be isolated from the rails at the entering sections, which causes elimination of the transit velocity restriction". Due to this solution it is possible to control pressure on the axles of rail vehicles and to conduct inspection on the wheels of rail vehicles at the speed of up to 240 km/h (fig. 2).

Nowadays complex solutions are offered on the market in the scope of automatic weighing and identification of rail vehicles of the RAIL WIM (Rail Weight in Motion) type. For Polish lines the equipment of the DSAT (detection of emergency of the rail rolling stock) type is used . Such devices allow for:

- assessment of the pressure exerted by rail vehicles ,
- detection of overheated , blocked brakes of rail vehicles,
- detection of overheated axle bearings of rail vehicles,
- detection of deformities of wheel raceway of rail vehicles .

Consequently, the application of the DSAT equipment plays its role in the safe realization of carriage services, that is, in reduction of risks of accidents, reduction of costs connected with the rolling stock's maintenance and in the extension of the lifespan of the infrastructure.

The temperature measurements are realized intangibly with the use of detectors working in the infrared band. Measurements of pressure and overload qualities are performed by light pipe detectors, which considerably allow avoiding the influence of electromagnetic interferences on the measurement value. The information obtained in this way is automatically processed by the electronic systems located in the by-rail compartment and transmitted to the operator stands of the PKP PLK S.A. which monitor rail vehicle movements, that is to the traffic engineering and technical services. Regularly new equipment of this type is installed on the main rail lines in Poland, on average twice a year in each region of particular rail agencies.

CONCLUSIONS

One of the most important objectives of the vehicle weight control systems is the elimination of the excessive damage of infrastructure by overloaded vehicles, which move along public roads and railways with exceeded permissible total weight or with big load pressure on the axles. The number of the road and rail infrastructure users is still increasing. The means of transport unsuitable for the carried shipment and in bad technical condition pose a risk not only for the state of the rail infrastructure but also for other users.

The WIM automatic systems for vehicle weighing seem to be a very good tool in the hands of the administrators of the transport infrastructure and control institutions. The previous experience is favourable in this respect. In the road transport, a good example is the system of automatic dynamic scales installed mainly on the main access roads to the city centre of Wrocław. In the rail transport, there are efficient systems of automatic vehicle weighing and control as well as the DSAT system for emergency detection of the rail rolling stock. Unfortunately, the systems displace the hitherto used systems of stationary or mobile static scales. Moreover, there are over thousand different kinds of weight control systems used in Poland and frequently they are analogue and require different kinds of interfaces which enable to interact with modern digital systems. These systems, mainly static ones, require continuous technical supervision along with authorization of scales, technical inspection and service repairs. These necessary activities are expensive and cause temporary disconnection of particular equipment and systems.

On the basis of the conducted analysis of the existing systems of weight control in road and rail transport in Poland a number of conclusions of strategic character can be formulated:

1) at present the vehicle weighing appliances have their limitations in the scope of measurement accuracy, therefore they can be used for vehicle preselection,
2) the improved WIM systems of the approved level of measurement should replace the conventional systems based on static measurement,
3) investment in new equipment and systems of vehicle weight control, though considerable, is profitable when compared with the costs of reconstruction of the transport infrastructure destroyed by overloaded vehicles,
4) additional advantage connected with replacement of the existing systems is the lack of increasing maintenance costs and adjustment to the requirements of the present digital systems,
5) the monitoring and control systems should be of intermodal character, that is, rail and road systems should interact and a common data base referring to overloaded vehicles should be accessible for all involved institutions and services in the real time
6) it is necessary to implement a number of changes of legislative character , especially to include statutory provisions which will enable to execute penalties on carriers by using the data bases from the systems of automatic weight control of vehicles in motion.

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SYSTEMY AUTOMATYCZNEJ KONTROLI WAGOWEJ POJAZDÓW W TRANSPORCIE DROGOWYM I KOLEJOWYM W POLSCE

STRESZCZENIE. Stan dróg w Polsce pomimo trwających prac remontowych jest w dalszym ciągu niezadawalający. Jedną z przyczyn jest nadmierne zużycie nawierzchni spowodowane przeciążonymi pojazdami. Problem ten dotyczy także transportu kolejowego, choć w dużo mniejszym zakresie. Jednym z rozwiązań systemowych może być automatyczna kontrola pojazdów w transporcie drogowym i kolejowym. Artykuł podaje uwarunkowania prawne i organizacyjne kontroli nienormatywnych pojazdów w Polsce. Scharakteryzowano obecnie stosowane praktyki ważenia pojazdów drogowych, oparte na technologiach pomiarów statycznych. Opisano istniejące możliwości zastosowania technologii automatycznego ważenia dynamicznego, określane, jako systemy WiM (Weigh in Motion). Scharakteryzowano technologie pomiaru i stanowiska pomiarowe w transporcie drogowym i kolejowym. Artykuł kończą autorskie wnioski wskazujące kierunki i sposoby udoskonalania systemów kontroli wagowej pojazdów.

Słowa kluczowe: transport drogowy, systemy ważenia pojazdów, ważenie dynamiczne i statyczne

DER AUTOMATISCHEN GEWICHTSKONTROLLE DER FAHRZEUGE IN DEN STRASSEN- UND SCHIENENVERKEHR IN POLEN

ZUSAMMENFASSUNG. Der Zustand der Straßen in Polen, trotz der laufenden Modernisierungsarbeiten, ist noch unbefriedigend. Die übermäßige Abnutzung der Oberfläche von überladenen Fahrzeugen ist einen von Gründen dafür. Dieses Problem betrifft auch den Schienenverkehr, aber in wesentlich geringerem Umfang. Eine Lösung kann das System der automatischen Gewichtskontrolle von Straßen-und Schienenfahrzeuge sein. Der Artikel beschreibt die rechtlichen und organisatorischen Bedingungen für die Inspektion von den übergroßen Fahrzeugen in Polen. Die derzeitigen Praktiken der Wiegen von Straßenfahrzeugen, die auf die Technologien der statischen Messungen basieren, wurden beschrieben. Der Artikel enthält die Beschreibung der vorhandenen Anwendungen der automatischen dynamische Wiegetechnik, die als Systeme WIM (Weigh in Motion) bekannt sind. Zusätzlich, wurden die Messtechnik und Wiegenstelle in Straße- und Schienentransport gekennzeichnet. Der Artikel endet mit Schlussfolgerungen von Autoren über die Richtungen und Methoden zur Verbesserung der Kontrollsysteme zum Wiegen der Fahrzeuge.

Codewörter: Straßenverkehr, Wiegesysteme von Fahrzeuge, dynamische und statische Wägung.

Bogusz Wisnicki, Anna Wolnowska
Institute of Transport Engineering
Maritime University of Szczecin
Waly Chrobrego 1-2, 70-500 Szczecin, Poland
e-mail: b.wisnicki@am.szczecin.pl
e-mail: a.wolnowska@am.szczecin.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 3
No 4

http://www.logforum.net

THE MODELING OF THE ASSEMBLY LINE WITH A TECHNOLOGICAL AUTOMATED GUIDED VEHICLE (AGV)

Aleksander Nieoczym[1], Sławomir Tarkowski[2]

[1)] Faculty of Mechanical Engineering, Lublin University of Technology, Lublin, Poland
[2)] The Faculty of Economic and Technical Sciences, College of Enterprise and Administration in Lublin, Lublin, Poland

ABSTRACT. The initial analysis of the work of the automated guided vehicle (AGV) in the assembly line was conducted. The method of defining a number of cells operated by one AGV was described. The method of the calculation of the optimal movement route and the stop spot in the initial setting was indicated. The formulas enabling to calculate the indicators of ways of the line functioning for various numbers of tasks were presented.

Key words: automated guided vehicle (AGV), assembly line, cell efficiency, demurrage time, work time.

INTRODUCTION

So called AGV trucks are one of the mainly used automatic guided vehicles. The principle of their functioning consists of the following the magnetic field created by the current flowing in the cable located in the floor of the factory through the aerials mounted on them. The topography of the cable corresponds the route of the AGV. AGVs could be equipped in platforms, rolls, forks, swivels and industrial robots and therefore they are able to cooperate with other machines. The addressing of AGVs to various branch circuits is possible (it concerns the multi-frequency vehicles) [Nieoczym 2011]. The truck has a PLC driver, which can contact with the superior controlling system by the optical connection.

The tactical and operational factors are taken into the consideration during the process of designing of AGV systems. The tactical factors [King, Kim 1999] are connected with the planning of physical elements of the system (e.g. amounts and location of receiving and dispatching points, means of transportation). The transport routes layout or the schedule of transport tasks are typical operational factors [Tanchoco 1991, King, Kim 1999]. They include also the area of the flows control, prediction and preventing of collisions and bottles necks within the transport routes or the localization of free transport means.

The operational factors are the superior ones in the process of designing of AGV systems [Koff 1997, Malmborg 2001]. The simultaneous methods [King, Kim 1999, Kom, Jea 2003] or their combinations with analytical methods [Mahadewan, Narendran 2001, Malmborg 2001] are used during the process of designing of AGV system to take into consideration so big number of decision-making variables. However, these methods are used in case of systems, which consist of a big number of vehicles, being able to transport big amounts of goods (e.g. the airport Schipol in Netherlands). The

Citation: Nieoczym A., Tarkowski Sł., 2011, The modeling of the assembly line with a technological automated guided vehicle (AGV). LogForum 7, 3, 4
URL: http://www.logforum.net/vol7/issue3/no4
Accepted: 11.06.2011, on-line: 5.08.2011.

attempts were also made to design AGV system by planning the cells' locations simultaneously with the process of designing of the distribution system [Aiello, Enea, Galante 2002]. The minimization of the system maintenance costs was the target function. Having a big number of calls, the designing problem can be simplified and reduced to an analytical model, which is formulated as the integer model [Johnson, Brandeau 1993] and solved by the used of analytical methods.

All above-mentioned methods of the process of designing of AGV system are time-consuming and need sophisticated mathematical methods. However sometimes, there is only a need to check quickly the initial assumptions of the project, to introduce the change in the input data or to prepare a simply simulation of the system work. The correctness of the project can be verified by the use of the formulas described in this paper, which give the number of posts operated by one AGV or by making the stochastic description of the way, how the transport system operates. The proposed methodology is based on the analysis of the loads of machines and limitations of the system, such as: the capacity of production warehouses, the capacity of the warehouse of final products, the throughput of internal transportation system.

It will be assumed for the purpose of this paper, that the assembly line consists of single cells connected by the transport flow and additionally these cells are operated by the automated guided vehicle. It is used to deliver small parts to workstations and to collect the assembled sets from these workstations.

Two main issues require the solutions:

- to calculate the number of assembly cells M operated by one AGV. The higher number of operated cells, the lower total assembly costs, but at the same time the efficiency decreases due to the fact, that there are demurrages because it is necessary to wait for services as well as the AGV itself is overloaded,
- to calculate the coefficient of the line utilization η with the given number of AGVs. This issue is solved mainly at the stage of the designing process of the assembly line. If this coefficient is determined improperly, the assumed production efficiency of the line could not be achieved. In the opposite case, when the production efficiency will be higher than assumed, then the line would be not fully used and its economical efficiency would decrease.

It is assumed in the preliminary calculations that the cells cooperated within the line, have the same parameters of the reliability, such as the intensity of damages λ and the intensity of the return to the work μ. Additionally, the problem of the reliability of the AGV is ignored [Nieoczym, Gajewski 2005, Yang, Yamafuri, Tanaka, 2000].

The following designations are assumed:

k – number of cells waiting to be operated (number of tasks to be done),

N – number of automated guided vehicles,

M – number of assembly cells.

THE DETERMINATION OF THE NUMBER OF CELLS OPERATED BY ONE AGV

Two coefficients are used in the calculations:

- coefficient of the time of the work of AGV on the assembly line:

$$\eta_t = \frac{T_{obs}}{T} \tag{1}$$

where: T_{obs} – service time of the assembly line by AGV,

T – total work time of the assembly line in the given period of time (e.g. one shift).

– coefficient of the efficiency of the cell:

$$\eta_c = \frac{Q_R}{Q_{nom}} \tag{2}$$

where: Q_R – real efficiency of the assembly cell taking into account the damages and blockings,

Q_{nom} – nominal efficiency of the assembly cell.

Assuming, that the efficiency of each cell is equal [Gujnar, Sanders 1994, Yang, Yamafuri, Tanaka, 2000], it can be written:

$$Q_R = \sum_{k=0}^{M} (M-k) P(M,t) \frac{Q_{nom}}{M} \tag{3}$$

where: $P(M,t)$ – the probability of serving of assembly cells in given time t.

Substituting this to the formula (2), it is obtained:

$$\eta_c = \sum_{k=0}^{M} (M-k) \frac{P(M,t)}{M} \tag{4}$$

$$\eta_t = \sum_{k=1}^{K} P(M,t) = 1 - P(0,t) \tag{5}$$

where: $P(0,t)$ – the probability, that there is no task to do by AGV in given time t.

If the assembly cells have the same values of parameters λ and μ, then the average number of repaired cells in the time interval $(0,t>$ is described as follows:

$$\overline{n_{rem}} = \mu \eta_t t \tag{6}$$

and the average number of cells, which will be damaged in the time interval $(0,t>$ [Gujnar, Sander 1994]:

$$\overline{n_{uszk}} = \lambda \sum_{k=0}^{M} (M-k) P(M,t) t = \lambda \eta_c M t \tag{7}$$

If the assembly processes are considered in sufficiently long intervals, there is a relationship:

$$\overline{n_{rem}} = \overline{n_{uszk}} \tag{8}$$

As a result, it will be:

$$\eta_c = \frac{\eta_t \mu}{M \lambda} \tag{9}$$

It means, η_c depends on ratio $\frac{\mu}{\lambda}$.

The maximal value of the efficiency coefficient η_c at the assumed value $\frac{\mu}{\lambda}$ can be found by the use of the iterative method and substituting the consecutive value of cells' number M.

THE DETERMINATION OF THE COEFFICIENT OF THE USE OF AUTOMATED GUIDED VEHICLE

The location of the AGV as an initial position should be determined after the calculation of cells' numbers operated by one AGV. This position should be chosen so, that the distances among the cells covered by the AGV should be minimized.

It is assumed, there are $M = (S_1, S_2, ...S_M)$ cells of different coefficients of the reliability located along the assembly line. The location of each of them is described by the coordinate x_i and the initial location of the AGV is characterized by the coordinate y (Fig. 1).

The time of work of a work cell is:

$$T = T_{op} + T_{obsl} + T_{oczek} \tag{10}$$

where: T_{op} – time of the technological operation at the workstation of the assembly cell,

T_{obsl} – service time by the AGV,

T_{ocz} –waiting time for the AGV.

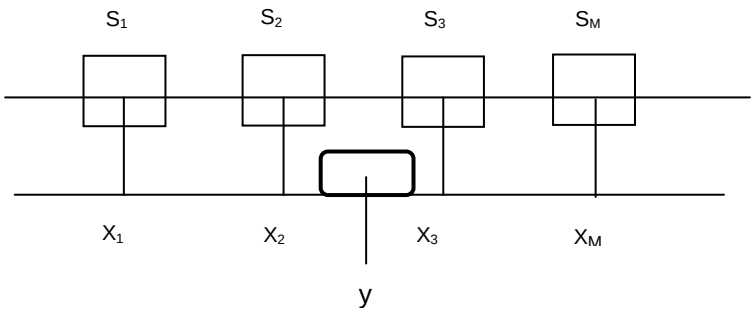

Fig. 1. The diagram of allocation of assembly cells and the location of AGV
Rys. 1. Schemat rozmieszczenia komórek montażowych i położenia sterowanego automatycznie wózka

The waiting time T_{oczek} - the time needed for the AGV to cover the distance between the initial location and the cell, needed to be operated:

$$T_{oczek} = \frac{|x_i - y|}{v} \quad i = (1...M) \tag{11}$$

where: y – location of the AGV in the initial position,

v – velocity of the AGV.

Assuming the extreme situation, when the AGV is at the cell, which should be operated but the cell is damaged. The service time of this cell is longer by the time T_{rem} needed to repair this cell.

$$T_{i\,obsl} = T_{i\,rem} + T_{i\,obs\,efekt} \tag{12}$$

It should be assumed additionally, that on the average, there are $\lambda_i T$ damages of i cell during T time of the line work. The time needed to repair this cell is equal to:

$$T_{i\,rem} = \lambda_i\, T\, \frac{1}{\mu_i} \tag{13}$$

The average total time to restore the readiness of the line for the work is equal to:

$$T_{rem} = T \sum_{i=1}^{M} \frac{\lambda_i}{\mu_i} \tag{14}$$

and the coefficient of the utilization of the AGV at the line is:

$$\eta = \frac{T_{op}}{T_{op} + T_{obs} + T_{oczek}} \tag{15}$$

Therefore, the location of the AGV in the initial position and its route affects the value of the η coefficient. This coefficient reaches the maximal value with the given values of λ and μ, when the value of the expression $|x_i - y|$ is minimal. The value of the following function should be calculated to find optimal values of *y*:

$$f(y) = \sum_{i=1}^{M} |x_i - y| . \tag{16}$$

The results of the function (16) with the assumptions, that:

- the distances between cells are the same and equal to *l*,
- there are *M*=4 cells in the operated zone,

are presented at the figure 2.

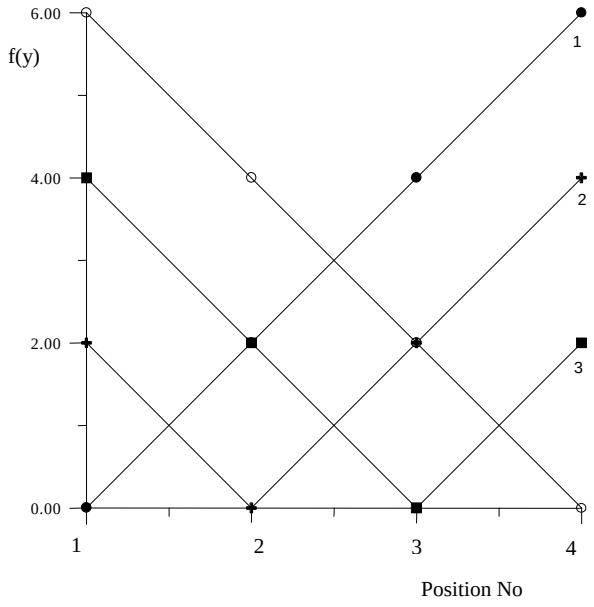

Fig. 2. The diagram of the dependence of the stop spots of the AGV on the route covered in the time of service of *M*=4 assembly cells. The AGV stop at the cell: 1 – first, 2 – second, 3- third, 4- fourth.
Rys. 2. Wykres miejsca postoju wózka sterowanego automatycznie od przebytej drogi w czasie obsługi M=4 komórek montażowych. Postój wózka przy komórce: 1 - pierwszej, 2 - drugiej, 3 - trzeciej, 4 - czwartej

The method, shown by King and Kim [1999] of the determination of the AGV location in the initial position by the analysis of covered route in left and right directions from this position, seems to be

unjustified due to its complexity. The proposed method is very simple and the graphical way of the presentation of results of the function allows to determine the optimal routes.

THE COEFFICIENTS USED TO DETAIL DESCRIPTION OF THE FUNCTIONING OF THE LINE WITH THE AUTOMATED GUIDED VEHICLE

In the case of the flexible manufacturing system, there is often the need to change the assembled sets and therefore various tasks fulfilled by the AGV. The following formulas, which take into consideration such changes and are based on the theory of mass operations [Nieoczym, Gajewski 2005, Nieoczym 2002], can be created:

- the probability, that there are *k* tasks to be done in *t* time on the line and the number of tasks is smaller than the number of AGVs:

$$P(M,t) = \frac{M!}{(M-k)!\,k!}\left(\frac{\lambda}{\mu}\right)^k P(0,t) \quad 1 \le k \le N \tag{17}$$

- the probability, that there are *k* tasks to be done in *t* time on the line and the number of tasks is bigger than the number of AGVs:

$$P(M,t) = \frac{M!}{(M-k)!\,N!\,N^{k-N}}\left(\frac{\lambda}{\mu}\right)P(0,t) \qquad N \le k \le M \tag{18}$$

- the average number of cells waiting to be operated:

$$M_{oczek} = \sum_{k=N+1}^{M} \frac{(k-N)\,M!}{N^{k-N}\,N!\,(M-k)!}\left(\frac{\lambda}{\mu}\right)^k P(0,t) \quad N \le k \le M \tag{19}$$

- the probability, that there are no tasks to be done in *t* time on the line by AGVs (*k*=0):

$$P(0,t) = \left[\sum_{k=0}^{N} \frac{M!}{k!\,(M-k)!}\left(\frac{\lambda}{\mu}\right)^k + \sum_{k=N+1}^{M} \frac{M!}{N^{k-N}\,N!\,(M-k)!}\left(\frac{\lambda}{\mu}\right)^k\right]^{-1} \tag{20}$$

- the average number of cells being operated:

$$M_{obsl} = \sum_{k=1}^{N} \frac{M!}{(k-1)!\,(M-k)!}\left(\frac{\lambda}{\mu}\right)^k P(0,t) \qquad 1 \le k \le N \tag{21}$$

$$M_{obsl} = \sum_{k=N+1}^{N} \frac{kM!}{N^{k-N}\,N!\,(M-k)!}\left(\frac{\lambda}{\mu}\right)^k P(0,t) \qquad N \le k \le M \tag{22}$$

– the coefficient of waiting time for a cell:

$$\frac{M_{oczek}}{M} = \frac{(M-1)!}{N!} \sum_{k=N+1}^{M} \frac{k-N}{N^{k-N}(M-k)!} P(0,t) \tag{23}$$

– the service coefficient of a cell:

$$\frac{M_{obsl}}{M} = \frac{1}{M} \sum_{k=1}^{M} k\ P(M,t) \tag{24}$$

SUMMARY

The presented paper can be regarded as a preliminary analysis of the work of the automated guided vehicle. The assumption, that the coefficients λ and μ of operated cells are of the same value, is the reason for that. The next part of the researches should be the determination of the scheduling of tasks and routes of AGVs in case, when the idle time is bigger than an assumed value, during which the AGV can wait for a cell to be returned to the work.

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MODELOWANIE LINII MONTAŻOWEJ Z TECHNOLOGICZNYM WÓZKIEM STEROWANYM AUTOMATYCZNIE

STRESZCZENIE. W artykule przeprowadzono wstępną analizę pracy wózka sterowanego automatycznie. Opisano metodę określenia liczby komórek obsługiwanych przez jeden wózek. Wskazano sposób obliczenia optymalnej trasy ruchu i miejsca postoju w położeniu wyjściowym. Zamieszczono wzory do obliczenia współczynników funkcjonowania linii przy różnych ilościach zadań.

Słowa kluczowe: wózek sterowany automatycznie, linia montażowa, wydajność komórki, czas uszkodzeń, czas pracy.

DIE MODELIERUNG VON MONTAGELINIE MIT DEM TECHNOLOGISCHEN FAHRERLOSEM TRANSPORTFAHRZEUG (AGV)

ZUSAMMENFASSUNG. Der Artikel präsentiert eine vorläufige Analyse der Arbeit von dem fahrerlosen Transportfahrzeug. Der Weg der Bestimmung der Anzahl der Zellen, die durch einen AGV unterstützt sind, wurde beschreibt. Die Methode zur Berechnung der optimalen Route für den Verkehr und des Parkplatz in die Ausgangsposition wurden angezeigt. Die Formeln für die Berechnung von der Koeffizienten der Arbeitsweise der Linie mit verschiedenen Mengen der Aufgaben wurden gegeben.

Codewörter: fahrerloses Transportfahrzeug, Montagelinie, Leistung von der Zelle, Verlustzeit, Arbeitszeit.

Aleksander Nieoczym
Katedra Podstaw Konstrukcji Maszyn Politechniki Lubelskiej
ul. Nadbystrzycka 36, 20-618 Lublin
e-mail: a.nieoczym@pollub.pl

Sławomir Tarkowski
Wydziału Nauk Ekonomicznych i Technicznych
Wyższej Szkoły Przedsiębiorczości i Administracji
ul. Bursaki 12, 20 -150 Lublin
e-mail: s.tarkowski@pollub.pl

LogForum

> Scientific Journal of Logistics <

http://www.logforum.net

ISSN 1734-459X
2011
Vol. 7
Issue 3
No 5

EVOLUTION OF THE TOTAL LOGISTICS COSTS CONCEPT

Valery S. Lukinskiy, Vladislav V. Lukinskiy, Tatiana G. Shulzhenko

Saint Petersburg State University, Saint Petersburg, Russia

ABSTRACT. The article considers the evolution stages of the total logistics cost concept; an interrelations of TLC and EOQ models has been analyzed. The author presented analytical approaches to determine a value of total cost, as well as an integral criterion for logistics systems' functioning, based upon package treatment of the total costs value and service level.

Key words: Total Logistics Cost model (TLC), logistics cost, service level, Economic Order Quantity (EOQ) model.

INTRODUCTION

According to research by various authors [Barykin 2007, Lukinski 2008, Dolgov 2004, etc.], one may state that costs-in-full dependence was covered in Ford Harris's work 'How Many Parts to Make at Once', 1913 [Operations ..., 1990], by way of:

$$y = \frac{1}{240 * M}(cx + s) + \frac{s}{x} + c \qquad (1)$$

where M is product consumption per month, in units;

c - a unit cost;

s - costs related to order management;

x - target order quantity, in units.

The work by Lukinski [2008] shows that value 240 in the formula (1), includes (2*12)/J, where J is a share in cost per unit as for production c, accounted for storage expenditures. In the mentioned work by F. Harris, value J = 0.1. Having finished necessary manipulations, it is easy to get the formula to calculate the economic order quantity, which according to present-day ideas is represented by way of:

$$x = \sqrt{\frac{2 * 12 * M * s}{J * c}} \qquad (2)$$

Thus, the first reference to 'total costs' equation (Total Logistics Costs, the TLC) and actually to the EOQ model, dates to 1913. At that two components have been considered, i.e. order management costs (C_3) and production storage costs (C_x):

Citation: V.S.Lukinskiy, V.V.Lukinskiy, T.G.Shulzhenko, 2011, Evolution of the total logistics costs concept. LogForum 7, 3, 5
URL: http://www.logforum.net/vol7/issue3/no5
Accepted: 7.07.2011, on-line: 5.08.2011.

$$C_{\sum} = C_з + C_x \qquad (3)$$

It must be emphasized that Ford Harris developed the formula for economic order quantity to estimate in-process inventory. For historical reasons, the economic order quantity model and the EOQ formula, called Wilson Formula, appeared between 1916 and 1934, when he published his article in The Harvard Business Review. Therefore some specialists consider that the formula (2) should be called Harris-Wilson Formula.

Moreover, according to the work by Bukan and Kenigsberg [1967], "having acted in-dependently", between 1915 and 1922, several American scientists „invented the formula for the most economic order quantity that minimized total product storage costs for cases, when demand was known and invariable."

We believe that to identify directions for further research and improvements to a logistics toolkit, we need to describe the evolution of one of fundamental concepts in logistics theory that is the total cost concept.

CO-EVOLUTION OF THE CONCEPT OF TOTAL LOGISTICS COSTS AND EOQ-MODEL

Summarizing above-mentioned reasoning, one may conclude that the first stage in the TLC and EOQ models development dates to 1913-1940 (Table); there are no essential differences between components of the TLC and EOQ models; their structure of elements is limited, while interrelations and mutual influence between elements of the models are not taken into consideration.

The second stage covers the period between 1940 and 1970. As far as logistics evolves, methodological approaches to cost analysis change: one may observe a move from isolated study of measures to rationalize distribution and production sphere to total costs accounting.

According to Lukinski [2008], in that time (1951) the work by K. Arrow, T. Harris and J. Marschak appeared, giving a mathematical analysis of the simple inventory control model, while in 1953, T. Whiting developed a probability version of the model [Hadley and Whiting, 1969]. Research made led to the new version of the total costs equation that might be presented by way of:

$$C_{\sum} = C_к + C_з + C_x + C_д \qquad (4)$$

where $C_к$, $C_з$, C_x, $C_д$ are correspondingly costs for purchasing, ordering, inventory storage and shortage costs.

At the same time, one should mention that some references related to inventory control, present the dependence (3) by way of:

$$C_{\sum} = C_з + C_{xm} + C_{xc} + C_д \qquad (5)$$

where C_{xm}, C_{xc} are storage costs for running and reserve inventory correspondingly.

Benchmarking study of (3), (4) and (5) models shows as follows: firstly, in the evolution process, a number of entered types of expenses increases; secondly, one may observe a difference between the second-generation models (second stage), e.g. in the formula (4), there are purchasing costs $C_к$, while in another one (5), those costs are not entered, although instead of total storage costs (Formula (4)), costs to store running and reserve inventory are introduced (Formula (5)); thirdly, a range of costs traditionally related to transportation, is not entered in dependencies (4) and (5), presenting main types of costs.

Let' look at the EOQ model. Two summands $C_з$ and C_x (for dependency (5) - C_m) can be evidently identified from each total costs dependency, and considered as constituents within the formula (3), it means getting back to the EOQ model's first stage. Nevertheless, a fundamental distinction of the second stage EOQ model is that it introduces the concept of 'inventory control strategy'.

Several strategies for inventory control are known to exist and based upon two models, i.e. a periodic one (a fixed interval between orders T and a variable delivery quantity S_i) and of critical levels (in particular, one critical level ('reorder level', the ROP) and the constant delivery quantity S_0. The second strategy has got another name, i.e. with a fixed order quantity (the FOQ).

Consideration of the inventory control strategy results in appearance of additional variable τ, lead time, in models. For example, for the fixed order quantity model, it is embodied in the value of 'reorder point' or 'order level' R. In presence of two variables, order quantity S and reorder point R, one need to draw a system of equations to identify their optimal values:

$$\begin{cases} \dfrac{\partial C_{\Sigma}}{\partial S} = 0 \\ \dfrac{\partial C_{\Sigma}}{\partial R} = 0 \end{cases} \tag{6}$$

Having been transformed, these dependences are written in the following form [Taha 2005] for the inventory control strategy, the *FOQ*:

$$\begin{cases} S^* = \sqrt{\dfrac{2A(C_0 + C_{\partial} F(S,R)}{C_x}} \\ \int\limits_{R^*}^{\infty} f(S)dS = \dfrac{C_x S^*}{C_{\partial} A} \end{cases} \tag{7}$$

where $F(S,R) = \int\limits_{R}^{\infty} (S-R) f(S) dS$.

For a standard law with density function f (S) in an explicit form it is impossible to identify optimal values of S* and R*, hence the numerical algorithm submitted by D. Hadley and T. Whiting is applied [Hadley and Whiting 1969].

Thus, for the second stage of the evolution in the total logistics cost model, sophistication of the model is characteristic in view of a number of its constituents and a diversity of applied calculation methods that in its turn is caused by development in the methodology of inventory control in logistics systems.

The third stage (1970-until present) is described with rapid developments in the theory of logistics and supply chain management. Along with that, in actually functioning commercial systems, one may observe that market relations are getting more sophisticated, competition is getting stronger, that inevitably result in a necessary increase in customer service quality. Establishing an integral criterion for efficient functioning of the logistics system that takes into account an amount of total logistics costs, on the one hand, and a level of customer service on the other hand, is a unique feature of the

given stage of the evolution within the considered concept. Formally, the given criterion can be written by way of the equations system as follows:

$$\begin{cases} C_{\Sigma}\ (C_i, S_0 < P) \to \min \\ SL(C_{\Sigma}\ , S, P_i) \to \max \end{cases}$$

where SL is service level, or demand satisfaction coefficient.

Structure sophistication of the total logistics costs model, on the one hand, and a need in applying integral criteria to assess efficiency of logistics systems functioning, on the other hand, at the first glance point out that the interrelation between the EOQ model and that of total logistics costs gets weaker (Table). Although it is not always true. A further analysis lets identify the interrelation and mutual influence between elements of considered models. For example, costs for purchasing inventory holdings are not taken into account within the EOQ model, while a contrary situation appears in case of purchasing goods with a discount; in general, transportation costs are not included into the EOQ model, but costs related to failed delivery risks are covered within the model.

Table 1. Main stages in development of total logistics costs concept
Tabela 1. Główne etapy rozwoju koncepcji kosztów całkowitych logistyki

Stage	Official representation of the model	Overall procedure for solving
First stage (1913-1940) Components of the total logistics cost model are independent	$C_{\Sigma} = C_з + C_x$	$Q = \sqrt{\frac{2AC_з}{C_x}}$
Second stage (1940-1970) Between the model components takes into account the relationship of inventory management strategies	1) $C_{\Sigma} = C_к + C_з + C_x + C_д$ 2) $C_{\Sigma} = C_з + C_m + C_c + C_д$	For example, for the strategy with a fixed order quantity $\begin{cases} \frac{\partial C_{\Sigma}}{\partial S} = 0 \\ \frac{\partial C_{\Sigma}}{\partial R} = 0 \end{cases}$
Third stage *(1970 until present)* Relationship and interaction of logistics key indicators (KPI), the total costs and service level	$C_{\Sigma} = C_к + C_з + C_x + C_c + C_д + C_л$ *I level* I, II *II level* C_m $C_{xp.}$ $C_{xp.1}$ $C_{xp.2}$ *III level* (C_m – transportation costs)	$\begin{cases} C_{\Sigma}\ (C_i, S_0 < P) \to \min \\ SL(C_{\Sigma}\ , S, P_i) \to \max \end{cases}$ Hence $\begin{cases} \frac{\partial C_{\Sigma}}{\partial S} = 0 \\ \frac{\partial C_{\Sigma}}{\partial R} = 0 \\ \frac{\partial SL}{\partial P_i} = 0, i = 1,..., n \end{cases}$

CONCLUSIONS

Thus, one needs to mention a range of important directions for advanced research. Firstly, in a domain of logistics commercial provision one needs to develop further a set of methods to estimate elements of the logistics costs system. Secondly, as far as the model gets more complex in its structure, a problem of search for criteria to group elements of the model is getting relevant to assess functioning of logistics systems in their various configurations, implemented logistics technologies and applied integration methods. Thirdly, we need further study of interrelations and mutual dependencies.

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EWOLUCJA KONCEPCJI CAŁKOWITYCH KOSZTÓW LOGISTYCZNYCH

STRESZCZENIE. Praca przedstawia etapy ewolucji koncepcji całkowitych kosztów logistycznych. Analizie poddano zależności między modelami TLC oraz EOQ. Autor przedstawił analityczne podejście określania wartości kosztów całkowitych, jak również kryteriów funkcjonowania systemów logistycznych, opierając się na zintegrowanym ujęciu wartości kosztów całkowitych oraz poziomu obsługi.

Słowa kluczowe: model całkowitych kosztów logistycznych (TLS), koszt logistyczny, poziom obsługi, model ekonomicznej wielkości zamówienia (EOQ).

ENTWICKLUNG DES KONZEPTS DER GESAMTEN LOGISTIKKOSTEN

ZUSAMMENFASSUNG. Der Artikel präsentiert die Etappen der Entwicklung des Konzepts der gesamten Logistikkosten. Die Beziehungen zwischen TLC und EOQ-Modelle wurden analysiert. Der Autor präsentiert einen analytischen Ansatz zur einem Wert der Gesamtkosten sowie integralen Kriterien für die Arbeitsweise von Logistik-Systemen, die auf einer integrierten Behandlung der Gesamtkosten und Service-Level basiert.

Codewörter: Modell von gesamten logistischen Kosten (TLC), logistische Kosten, Service Level, Modell der ökonomische Bestellmenge (EOQ).

Valery S. Lukinskiy
Doctor of Engineering, professor, Department Chair,
Department of Logistics and Transport Management
Saint Petersburg State University
of Engineering and Economics
27, Marata str., Saint-Petersburg, Russia
e-mail: dept.kliop@engec.ru

Vladislav V. Lukinskiy
Doctor of Economics, professor
at Department of Logistics and Transport Management
27, Marata str., Saint-Petersburg, Russia
e-mail: dept.kliop@engec.ru

Tatiana G. Shulzhenko
Ph.D. in Economics, assistant professor
at Department of Logistics and Transport Management
27, Marata str., Saint-Petersburg, Russia
e-mail: dept.kliop@engec.ru

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 1

http://www.logforum.net

SUPPLIER PERFORMANCE MONITORING AND IMPROVEMENT (SPMI) THROUGH SIPOC ANALYSIS AND PDCA MODEL TO THE ISO 9001 QMS IN SPORTS GOODS MANUFACTURING INDUSTRY

S. Parkash, Dr. Veerender Kumar Kaushik

1) Singhania University, Rajasthan, India 2) Technological Institute of Textile & Sciences, Bhiwani, Haryana, India

ABSTRACT. Background: Increasing global competition and customer expectations are forcing companies to improve their supplier performance as part of their supply chain governance initiative. A sport goods manufacturing industry is intensive supplier base industry and majority of these comes under small medium enterprises with limited resources. Developing an easy - deploy, cost effective and result oriented frame work for this industry is a critical business competency.
Methods: This paper lays out a framework - a "standard operating system" - for continuous supplier performance monitoring and improvement (SPMI) and is composed of following sections. In the first section supplier performance monitoring and improvement is overviewed with its basic concepts, and then improvement methods used in the paper are explained based on literature review. The third and fourth section focus on the methodology, explaining the way of SIPOC Analysis and PDCA application with using ISO 9001; 2008 QMS standards and example showing its results.
Results: The existing process of Supplier Performance Monitoring and Improvement (SPMI) was defined and mapped and then analyzed and revised through SIPOC Analysis by incorporating to PDCA Cycle and ISO 9001 QMS to identify problem areas, variations and unnecessary activities. Corrective actions were recommended to deal with problem areas and an improved and revised Supplier Performance Monitoring and Improvement (SPMI) Process is suggested.
Conclusions: Every organization needs to use a proper combination and selection of quality tools, methodologies and techniques for implementing continuous quality improvement process. This framework will provide a guidance for anyone who wants to develop supplier performance measurement system in sports goods manufacturing industry and other small - medium enterprises.

Key words: Supplier Performance Improvement, Process Approach, Supply Chain Management, Purchasing, ISO 9001.

INTRODUCTION

A supplier performance expectation can be defined as "a specific statement of a business practice, process, policy and/or the results anticipated or required from a supplier's performance or behavior in relation to the customer" [Gordon 2008]. Continuously improving the performance of suppliers, a critical component of overall supply and demand chain management, can have a material impact on sports goods manufacturing industry's revenue growth and operating margin.

Supplier performance monitoring and improvement (SPMI) is a business practice that is used to analyze and improve the performance of a supplier's performance in an effort to cut costs, alleviate risks, and drive continuous improvement. This can help companies have better visibility into supplier deliverables and offer benefits to uncover and remove hidden cost drivers from poor quality, increase competitive advantage by reducing order cycle times, chargeback's for non-conforming material and

Citation: Parkash S., Kaushik V.K., 2011, Supplier Performance Monitoring & Improvement (SPMI) through SIPOC Analysis & PDCA Model to the ISO 9001 QMS in Sports Goods Manufacturing Industry. LogForum 7, 4, 1
URL: http://www.logforum.net/vol7/issue4/no1
Accepted: 11.09.2011, on-line: 5.10.2011.

supplies, gain insight on how to best leverage their supply base, and align practices between themselves and their suppliers.

Our Supplier Performance Monitoring and Improvement (SPMI) framework basically depends on finding the answers of following questions: "What do we want to happen with suppliers, and how do we want it to happen?" and "What actually happened, and why did it happen?" "How do we do better than last time?" and "How do we do better than industry averages?" In this pursuit, the author having worked as Head of Materials Department in one of the reputed Sports Goods Industry with in India for more than 12 years selected this as a single exploratory case study to find out answers of these questions.

This paper lays out a framework - a "standard operating system" - for continuous supplier performance monitoring and improvement (SPMI) and is composed of five sections. In the following section supplier performance monitoring & improvement is overviewed with its basic concepts, and then improvement methods used in the paper are explained based on literature review. The third and fourth section focuses on the methodology explaining the way of SIPOC Analysis & PDCA application with using ISO 9001; 2008 QMS standards and example showing its results. In the final section, the results are discussed and commented.

LITERATURE REVIEW

There are a number of factors, which have created the storm in the supplier performance world: Increased outsourcing, Globalization of business and of supply chains, increasing complexity in managing suppliers, increasing supply risks etc.

Viewing suppliers not just as a cost, but as a strategic input to their bottom line

"Supply Management is a process responsible for the development & management of a firm's total supply system - focuses heavily on the strategic aspects of the key elements of a firm's supply system." "Supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer & suppliers, but also transporters, warehouses, retailers and customer themselves." [Chopra Meindl 2001]

"Good supplier performance is a key ingredient in enabling firms to achieve business performance excellence. But how can firms manage or even influence the performance of outside suppliers? Supplier performance improvement (SPMI) is being widely adopted as a method to understand and improve the performance of the extended enterprise." [Gordon 2010]. "However, without careful monitoring of supplier performance, a firm is unable to accurately assess whether its current suppliers are meeting the needs of the firm, and suppliers are unable to respond to unexpressed partner needs." [Simpson at el. 2002]. Supplier performance Monitoring and improvement (SPMI) is a mechanism to track supplier progress towards meeting organizational goals, and gives feedback to the supplier base on their individual performance.

A perfect Supplier Performance Monitoring & Improvement (SPMI) adds value as a:

- Tool to increase a two-way flow of communication between customer and supplier,
- Way to improve supplier performance as well as uncover better processes that they as a customer can enable better relationships and performance,
- Tool to uncover hidden costs and cost drivers,
- Means to improve a customer's own market competitiveness in the process of strengthening their part of the value chain.

A Perfect SPMI program should:

- Align with objectives of the firm, not be focused only on Procurement,
- Planned and designed with those corporate goals in mind - not just "happen",

- Improve and monitor progress against a plan based on supplier performance measures,
- Undergo scheduled reviews and improvement processes,
- Provide diligent communication and follow-up,
- Conduct regular business/performance review meetings to discuss performance feedback, action items and plans, and share mutual improvement ideas,
- Distribute supplier performance score cards on a timely and regular basis,
- Provide supplier development resources,
- Ask the supplier for feedback about the customer (known as 360° feedback or reverse scorecards) - and to actually take action on the feedback. So often the customer's own business processes, practices and behaviors can prevent suppliers from performing well and need to be addressed and improved,
- Develop perfect recognition programs for top performers,
- Trend analysis, such as trends of individual supplier performance scores over time and comparison of suppliers with each other,
- Alerts regarding performance issues,
- Tracking corrective actions & improvement plans,
- Take quick actions Once there is sudden drop in supplier performance or a downward trend Some actions that can be done include communicating with the supplier, conducting further evaluations, developing an improvement plan, or finding an alternative supplier. The actions taken may depend on many factors. These include the supplier's past performance, level of current performance, strategic importance, possible damages, and overall risk.

ISO 9001QMS

ISO (International Organization for Standardization) is established "to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services and to developing cooperation in the spheres of intellectual, scientific, technological, and economic activity."

ISO9001 QMS is a flexible standard for the requirements of quality management systems for purposes of internal application by organization, certification and contractual purposes. Field of business. Not only can this standard be applied in public-sector organizations or private-sector organizations of any size, it can also be applied to any field, from manufacturing to services and software. It is possible to incorporate actively what seems necessary for its business activities.

Process

An activity using resource management, and managed in order to enable the transformation of inputs into outputs (Extract from ISO9000:2000 Fundamentals and vocabulary 0.2).

For Example: Purchasing Control (ISO9001, Clause 4.6).

Is there a system for assessing sub contractors & vendors?

Do you have a documented procedure for evaluating sub contractors and vendors? [Lal 1996]

References to processes in ISO 9001:2008:

In sub clause 4.1 General requirements: "The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of this International Standard. The organization shall:

a) Determine the processes needed for the quality management system and their application throughout the organization

b) Determine the sequence and interaction of these processes,

c) Determine criteria and methods needed to ensure that both the operation and control of these processes are effective,

d) Ensure the availability of resources and information necessary to support the operation and monitoring of these processes,

e) Monitor, measure (where applicable), and analyze these processes, and

f) Implement actions necessary to achieve planned results and continual improvement of these processes.

These processes shall be managed by the organization in accordance with the requirements of this International Standard".

Based on the above, each organization should define the number and type of processes needed to fulfill its business objectives. It is permissible for a process that is required by ISO 9001:2008 to be part of a process (or processes) that is already established by the organization, or to be defined by the organization in terms that are different to those in ISO 9001. [Introduction .... 2010]

Process approach

In sub clause 0.2 of ISO 9001 Process Approach: "The application of a system of processes within an organization, together with the identification and interactions of these processes, and their management to produce the desired outcome, can be referred to as the "process approach".

The distinctive characteristics of processes

A process makes it possible to define what activities and operations are to be performed, to what extent, with what objectives and with what results (output).

A process makes it possible to perform activities and operations not a single time, but repeatedly.

A process makes it possible to measure (evaluate) the output (value added) of activities and operations.

A process makes it possible to predict what results activities and processes will have.

"Plan-Do-Check-Act" (PDCA*) can be applied to all processes.

PDCA

PDCA (Plan-Do-Check-Act) can be briefly described as follows.

Plan: establish the objectives and processes necessary to deliver results in accordance with customer requirements and the organization's policies.

Do: implement the processes.

Check: monitor and measure processes and product against policies, objectives and requirements for the product and report the results.

Act: take actions to continually improve process performance.

The PDCA is a dynamic methodology that can be deployed within each of the organization's processes and across their interactions. The Plan-Do-Check-Act (PDCA) methodology can be a useful tool to define, implement and control corrective actions and improvements.

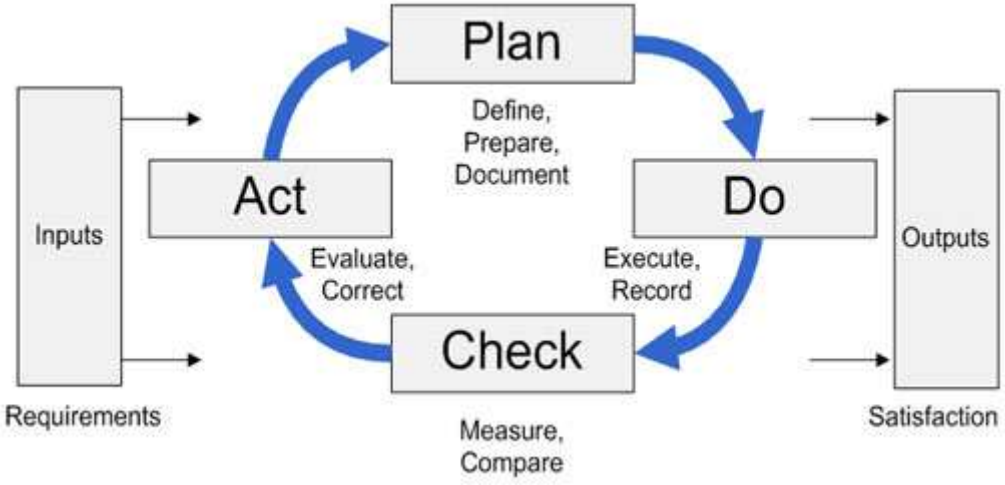

Fig. 1. PDCA (Plan-Do-Check-Act)
Rys. 1. Schemat PDCA

The PDCA cycle is a well-known fundamental concept of continuous-improvement processes. This is also referred to as the Deming circle, named after W. E. Deming. The PDCA cycle is effective in both doing a job and managing a programme. The PDCA cycle enables two types of corrective action - temporary and permanent. The temporary action is aimed at results by practically tackling and fixing the problem. The permanent corrective action, on the other hand, consists of investigation and eliminating the root causes and thus targets the sustainability of the improved process. The aspects of the PDCA cycle were applied to internal quality-assurance procedures:

- What are we trying to accomplish?
- How will we know that a change is an improvement?
- What changes can we make to improve? [Sokovic, Pavletic, Pipan 2010].

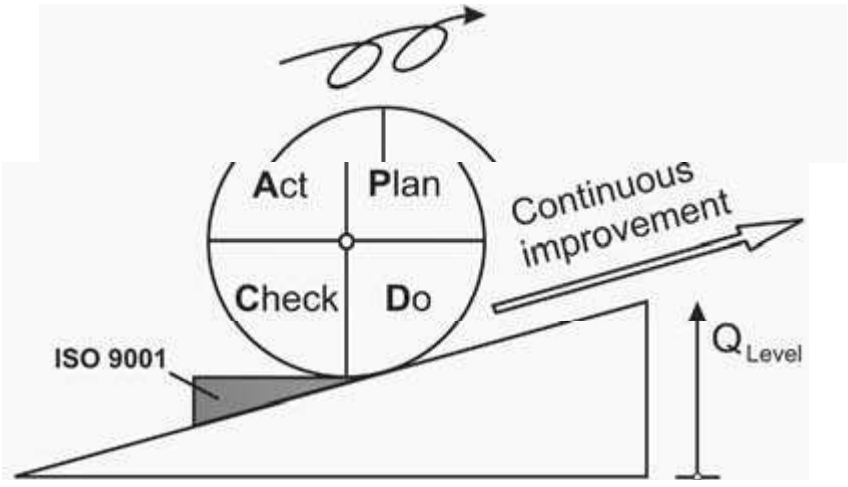

Fig. 2. PDCA cycle in continuous improvement process [Sokovic, Pavletic, Pipan 2010]
Rys. 2. Cykl PDCA w procesie ciągłego doskonalenia [Sokovic, Pavletic, Pipan 2010]

By following the Plan-Do-Check-Act (PDCA) cycle, the process is defined and documented properly, executed, has its results measured and is continually evaluated to look for improvement opportunities. The better understanding of how the process is working, enable to see required corrective actions and improvements. Whenever corrective actions are needed, the method for

implementing them should be defined. This should include the identification and elimination of the root causes of the problems (e.g. errors, defects, lack of adequate process controls). The effectiveness of the actions taken should be reviewed. Implement the corrective actions and verify their effectiveness according to plan. When planned process outcomes are being achieved and requirements fulfilled, the organization should focus its efforts on actions to improve process performance to higher levels, on a continual basis.

SIPOC, ONE OF THE KEY PROCESS ANALYSIS & IMPROVEMENT TOOLS

SIPOC stands for Suppliers, Inputs, Process, Outputs, and Clients. SIPOC analysis is a methodology for process improvement employing analysis based on diagrammatic representation of key elements of a process namely, Suppliers, Inputs of the process, Process itself, Outputs of the process and Customers (the recipients of the process). This analytical tool is used mainly for understanding and further improving an individual process within a business. SIPOC is a tool for Continuous Improvement (TQM).

The SIPOC or Supplier Input Process Output Customer is a process flow format that helps us to:

- Understand what inputs are required to attain the correct output,
- Develop team purpose or mission,
- Identify possible "quick hit" opportunities to eliminate some non value-added outputs,
- Select a core process to redesign,
- Clarity key customer or supplier relationships needing improvement.

Suppliers and Customers are WHOs, Inputs and Outputs are WHATs, and Processes are HOWs. Therefore, the S, I, O, and C columns should be lists of nouns. The Process column should be written in the form Verb-Direct Object, e.g., take orders and Select vendors, etc.

For each element of SIPOC - starting from the customer - ask our self:

1. Who are our customers and what do they want?
2. What outputs (goods or services) with features and benefits must we provide?
3. What processes and systems are needed to produce those outputs and how are they currently monitored?
4. What inputs are needed?
5. Which suppliers can best provide the needed input - and how do we know this?

To complete the SIPOC Chain:

- Start with Product/Service Outputs,
- Then work backwards from there by identifying the Processes that produce those outputs,
- The Inputs to those processes, and

- The Suppliers of those inputs (both internal and external).
- Finish by identifying all Customers (internal and external), i.e., anyone who receives and uses your Product/Service outputs.

Divide list of processes into three types:

Core processes directly add value to customer

Examples are: New Product Design, Production, After-sales support

Support processes enable the Core processes

Examples are: Finance, Facilities management, Information management

Governing processes direct or monitor other processes

Examples are: Strategic Planning, Performance Reviews

A common use of SIPOC is to develop a list of processes, then select one or

More to improve. Analyze the customer - supply chain of concerned process to identify areas for improvement. Use a red pen to "flag" any areas in your chain where:

- Customer requirements are not clear,
- Outputs are non value-added and can be eliminated,
- Processes aren't functioning effectively,
- Supplier performance is not satisfactory.

Making Improvements can address identified opportunities.

When selecting a process for improvement, consider the following criteria to ensure you focus your improvement efforts on the VITAL few processes:

Versus - How large is the gap versus competitors? Versus customers' perception?

Influence - To what extent will improvement in this area influence other areas?

Timing - How urgent is it we improve in that area now? Other things we should do first?

Appetite - Is there enthusiasm for achieving this goal? Improving this process?

Likelihood of success - How feasible is it? Do we currently have the required?

Capabilities in that area? Can we develop them?

In addition to these criteria, it is usually best to map, analyze and improve a process that…

- Is existing (versus designing a new one).
- Involves multiple individuals groups or functions.
- The right team can be assembled, including those with sufficient understanding of how it works and authority to change it.
- You are not certain how to improve it, i.e., the answer is "unknown".

"The SIPOC helps the Team reach consensus on the simple scope and purpose of the process and the project…To that end; it is a potent change management tool. The useful outputs of the tools are: an agreed process scope and process, the beginning of a list of customers to feed into Voice of Customers (VOC) work…." [Wedgwood 2007] "SIPOCs do not focus on "how the process is completed" rather, they focus on the complex interrelationships between activities, from the perspective of Suppliers

feeding Inputs or data into the process, and when the process has completed its activity the Output that gets fed to a Customer." [NSSC Implementation Plan Report 2003].

Theoretical model showing relation between research question and theory presented in Fig 3.

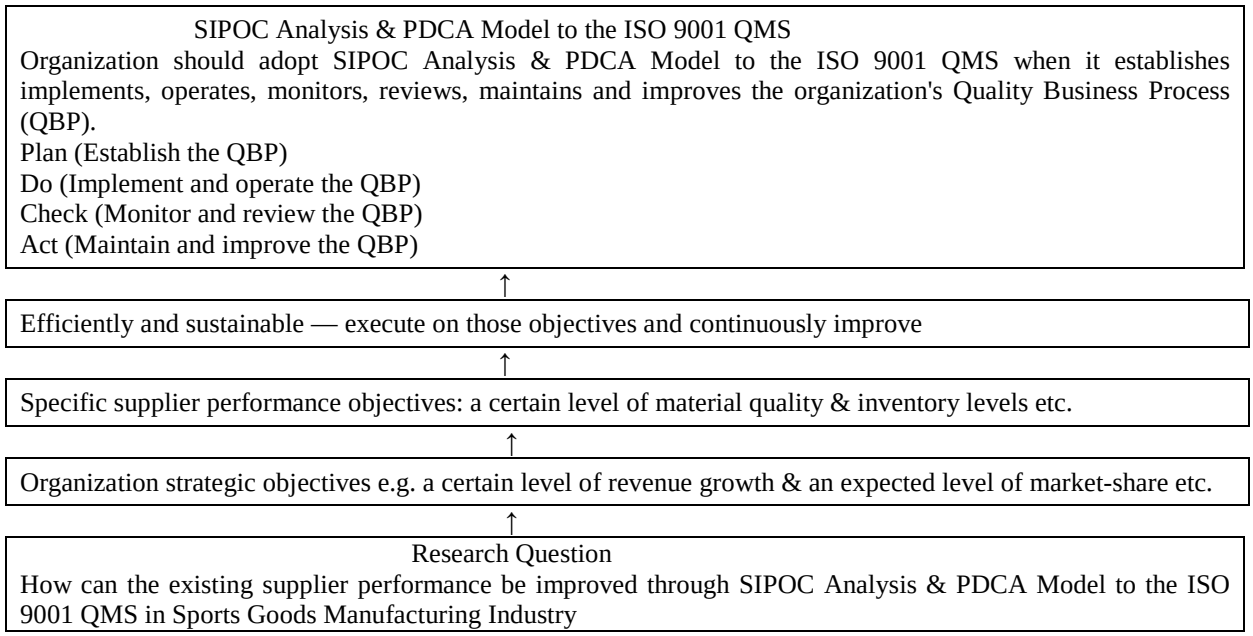

Fig. 3. Theoretical model showing relation between research question & theory presented
Rys. 3. Model teoretyczny przedstawiający relację między pytaniem badania a przedstawioną teorią

METHODOLOGY

Methodology is, broadly speaking, the way in which a researcher conducts research. [Jonker, Pennink 2010] This research paper is a descriptive case study with a deductive approach. "The case study, like other research strategies, is a way of investigating an empirical topic by following a set of pre-specified procedures.

The case study method has a distinct advantage in situations when a "how" or "why" question is being asked about a contemporary set of events, over which the investigator has little or no control and when the focus is on contemporary phenomenon within some real-life context" [Yin 2003]. One of the reputed sports goods manufacturing industry from India has been taken as case study of this research study. This study has mainly a positivism approach by using general theories such as SIPOC Analysis and PDCA cycle to ISO 9001 QMS for improving supplier performance at referred industry. The information used was collected from historical/current data from concerned industry itself. Deductive approach is used because it is a theory-based research leading towards the findings.

Scientific Method of Study:

Here the qualitative research method is used in order to understand the current Process in depth. And suggest improvements after identifying the variations, unnecessary activities and problems. This research paper will study the referred industry's current supplier performance improvement process about what kind of Problems there are in the current process; furthermore, create an improved process map in order to get continuous improvement objectives.

Data collection:

In this study, both primary and secondary data were collected. The primary data was gathered through observations. The secondary data were collected from literature and scientific articles. The search engines such as GOOGLE, Emerald, and Business Source Premier were used to find scholarly

articles and reliable information. The words as supplier performance management, supplier evaluation, Process Approach, ISO 9001 and supply chain management were used to find relevant information and articles.

EMPIRICAL FINDINGS AND ANALYSIS

Empirical information was gathered through direct in-plant observations.

By the application of the "Plan-Do-Check-Act (PDCA)" model & SIPOC Analysis to process associated with supplier performance monitoring and improvement (SPMI), the effect i.e. continual improvement of supplier performance as expected can be produced as outputs.

Research Question
How can the existing supplier performance be improved through the PDCA Model & the SIPOC Analysis to the ISO 9001 QMS in Sports Goods Manufacturing Industry?

↓

Theoretical Framework: Organization should adopt the PDCA Model & the SIPOC Analysis to the ISO 9001 QMS in Sports Goods Manufacturing Industry? When it establishes, implements, operates, monitors, reviews, maintains and improves the organization's Quality Business Process (QBP) of Supplier Performance Improvement (SPI).

Plan (Establish the Quality Business Process i.e.)	Do (Implement and operate the QBP)	Check (Monitor and review the QBP)	Act (Maintain and improve the QBP)

↓

EMPIRICAL FINDINGS

Referred Sports Industry Supplier Performance Improvement Process establish QBP processes and procedures for improving supplier performance to deliver results in accordance with an organization overall policies and objectives.	Implement the QBP controls, processes and procedures.	Assess and, where applicable, measure process performance and report the results to management for review.	Take corrective and preventive actions, based on the performance and management review to achieve continual improvement of the QBP.

↓

EMPIRICAL ANALYSIS

Define process, focus & characteristics	Investigate existing process maps	Investigate & analyze problem areas	Investigate & suggest improvements & improved process map

Plan: What is the focus of process? ; Whom to improve?

Supplier performance improvement is the focus of process. First we needed to determine whom to improve? i.e. Supplier Selection "Firms should concentrate on strategic suppliers who are integrated business partners as well as core suppliers, who require integration and development plus other suppliers that may supply a high-cost or high-risk item." [Barrett at el. 2008]. Here as discussed with the firms Director Operation, all strategically large & critical suppliers are selected.

Do: How does the process work?

It relates to measuring and mapping the current process to describe and understand

The current process in details. Current supplier Performance Monitoring and Improvement Process map is analyzed through SIPOC Analysis

EXISTING SIPOC (Customer-Supplier Chain)

Process Name: Supplier Performance Evaluation & Improvement

SUPPLIERS (Providers of the required resources)	INPUTS (Resources required by the process)	PROCESSES (Top level description of activity)	PRODUCT/SERVICE OUTPUTS (Deliverables from the process)	CUSTOMERS (Anyone who receives a delibarable from the process)
S	⇨	⇧	⇨	C
Purchase, Store & Incoming inspection	The performance measures details (i.e. Quality, Delivery, Competitive Pricing & Proper Responsiveness	Collection & Compi-lation of performance measures details on quarterly basis	Compiled database of Delivery, Quality, Competitive Pricing & Proper Responsiveness	Purchase
	Compiled database of Delivery, Quality, Competitive Pricing & Proper Responsiveness	Calculation of Supplier Performance		
Purchase	& Working Instructions for supplier performance assessment		Supplier Performance Score Card	Purchase
	Supplier Performance Score Card			
		Sending Score Card to poor performers & asking for corrective action report to further improve		
Purchase	The performance measures details(i.e. Quality, Delivery, Competitive Pricing & Proper Responsiveness	Verification of corrective actions by checking next two supplies	Corrective action report from supplier	Purchase
	Verification status			
Purchase, Store & Incoming inspection	Receipt of delivery + inspection details of next one or two supplies WHA	If verification status is ok , monitor performance in next quarter & If not ok, Delete from approved supplier list	Verification Status Report(OK or NOT OK)	Purchase
		HOW	If again poor supplier rating	Supplier
			Deletion Letter	Supplier
Purchase			Updated ASL	Purchase
Materials Manager				
Materials Manager				
WHO			WHAT	WHO

EXISTING SIPOC (Customer-Supplier Chain)

Check & Act: What are the problems? and What can be improved?

Detailed & careful study of feedback of supplier performance expectation Vis actual supplier performance monitored, if shows downward trends and deterioration in performance than that can signal a problem. One of the first things to do is to contact the supplier and find out what went wrong and why. The supplier, personnel can determine the cause of the problem.

The problems identified are discussed below in relation to current supplier Performance Monitoring and Improvement Process map:

1. Sometimes user is unable to generate proper forecast regarding required material and normal need becomes urgent & require urgent change in delivery time after placing purchase order leads in the reduction of number of days in delivery time resulting in to less time for order fullfillment. Supplier in haste may do waste.
2. Supplier performance measurement on half yearly basis is quite long period as supplier himself forget the real cause of poor performance
3. Current supplier performance monitoring process does not go with supplier segmentation/selection. Therefore targeting/concentrating effort/resource is not possible
4. Involvement of senior management is not there in current supplier performance monitoring and improvement process
5. Distribute Supplier Performance Cards were being distributed to only poor performing suppliers only instead of all measured suppliers
6. Setting & aligning expected Supplier performance targets are not there in current supplier performance monitoring & improvement process
7. Comparison of actual performance with expected Supplier performance targets is absent. Therefore a true gap analysis is very difficult
8. Holding personal meeting is absent with poor performers to discuss performance feedback, corrective action plans & share mutual improvement idea
9. Organizing Suppliers Recognition events i.e. providing Memento / Certificate to good performers by organizing get to gather is also not there
10. Issuing notice to poor performers if their corrective action verification report has been found not ok prior to deletion from ASL is also absent in SIPOC Analysis of existing QBP to poor performers, if result of verification of corrective action verification report is not ok, issue notice regarding deletion from ASL & develop new supplier as back up. If performance is still not ok in the next quarter rating, delete from ASL.

Now we have identified the problem areas in the current supplier performance monitoring and improvement process of referred sports goods manufacturing industry. Finding problem areas in the supplier performance improvement process helped us to ascertain how the Process is actually working right now and what improvements opportunities there are to make it more effective and accordingly. Following Revised SIPOC (Customer - Supply Chain) with required improvements for revised supplier performance monitoring & improvement process is drafted.

REVISED SIPOC (Customer-Supplier Chain):-

Process Name: Supplier Performance Evaluation & Improvement

SUPPLIERS (Providers of the required resources)	INPUTS (Resources required by the process)	PROCESSES (Top level description of activity)	PRODUCT/SERVICE OUTPUTS (Deliverables from the process)	CUSTOMERS (Anyone who receives a delibarable from the process)
S	⇨	△	⇨	C
Senior Management	Corporate targets within business plan	Involve senior management to Set & align expected Supplier performance targets	Expected Supplier performance targets	Purchase Dept
		Select high value added strategic & critical suppliers		
Purchase	Approved Supplier List	Intimate performance rating method to selected suppliers	Selected supplier list for performance monitoring & improvement	Purchase Dept
		Prepare Supplier Performance Score Card for each selected supplier		
Purchase	Selected Supplier List	Distribute Supplier Performance Card to all measured suppliers	Intimation letter regarding performance rating procedure	Selected Suppliers
Purchase, Incoming Inspection & Store / User	Suppliers Performance Measures Data	Compare actual performance with expected one	Supplier Performance Score Card	Purchase Dept
	Supplier performance card	Holding personal meeting with poor performers to discuss performance feedback, corrective action plans & share mutual improvement idea	Intimation Letter along with supplier performance card	Supplier
Purchase	Expected Supplier performance targets & actual Supplier Performance Score Card	Organizing Suppliers Recognition events	A true gap analysis	Purchase
Purchase	Supplier Performance Score Card	Verification of Corrective action report of supplier by keen watch of two or three subsequent supplies	Corrective action plan & required training plan	Supplier
Purchase	Supplier Performance Score Card	If still not ok, issue notice regarding deletion from ASL & develop new supplier as back up. If performance is still not ok in the next quarter rating, delete from ASL	Memento / Certificate to good performers	Suppliers
Purchase	Verification Status	HOW	Verification Status (OK or NOT OK)	Purchase
Purchase	WHAT		Notice / Deletion Letter	Purchase
WHO			WHAT	WHO

CONCLUSION

Every organization needs to use a proper combination and selection of quality tools, methodologies and techniques for implementing continuous quality improvement process. The existing process of Supplier Performance Monitoring & Improvement (SPMI) was defined and mapped to understand the process characteristics and capabilities. The existing process was then analyzed and revised through SIPOC Analysis by incorporating to PDCA Cycle and ISO 9001 QMS to identify problem areas, variations and unnecessary activities. Corrective actions were recommended to deal with problem areas and an improved and revised Supplier Performance Monitoring & Improvement (SPMI) Process is suggested. The PDCA Cycle is simple to understand and should be used by a large number of people in the company (also throughout standard ISO 9001:2008). This framework will hopefully provide guidance for anyone who wants to develop supplier performance measurement system in sports goods manufacturing industry and other small - medium enterprises.

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MONITORING I DOSKONALENIE DZIAŁALNOŚCI DOSTAWCY PRZY ZASTOSOWANIU ANALIZY SIPOC ORAZ MODELU PDCA I ISO 9001 QMS W PRZEMYŚLE WYROBÓW SPORTOWYCH

STRESZCZENIE. **Wstęp**: Wzrost konkurencji na rynkach globalnych oraz oczekiwań klientów zmusza przedsiębiorstwa do poprawy działania swoich dostawców, którzy stanowią część ich łańcucha dostaw. Przemysł wytwórczy sprzętu sportowego jest przemysłem bardzo zależnym od dostawców a jednocześnie większość przedsiębiorstw należących do niego, to małe przedsiębiorstwa z ograniczonymi zasobami. W związku z tym wypracowanie prostej w zastosowaniu i nastawionej na ograniczenie kosztów metody działania jest dla nich kluczowym zagadnieniem.
Metody: Praca przedstawia metodę poprawy działania swoich dostawców uwzględniając podejście procesowe do zagadnienia, która została ujęta w następujące etapy. W pierwszej części dokonano przeglądu literaturowego metod monitoringu i poprawny działań dostawców poprzez porównanie do podstawowych koncepcji. Następnie przeanalizowano metody usprawniające tą działalność. W trzeciej i czwartej części skupiono się na metodologii oraz omówieniu metod SIPOC i PDCA z zastosowaniem standardów ISO 9001 i 2008 QMS oraz zaprezentowaniu przykładu wyjaśniającego wyniki.
Wyniki: Istniejący proces monitoringu i poprawy działania dostawców (SPMI) został zdefiniowany, zmapowany a następnie poddany analizie przy zastosowaniu metody SIPOC oraz cyklu PDCA i ISO 9001 QMS w celu zidentyfikowania potencjalnych problematycznych sytuacji, zdarzeń i zbędnych czynności. Zaproponowano odpowiednie środki zaradcze do zastosowaniu w obszarach problematycznych oraz zasugerowano poprawę procesu monitoringu i poprawę działań dostawców (SPMI).
Wnioski: Każda organizacji dla prawidłowego funkcjonowania wymaga odpowiedniego zestawu narzędzi, metodologii i technik wdrażających i umożliwiających realizację procesu poprawy jakości. Praca ta przedstawia wytyczne dla wdrożenia systemu oceny działalności dostawców w przemyśle wytwórczym sprzętu sportowego w obszarze małych i średnich przedsiębiorstw.

Słowa kluczowe: doskonalenie pracy dostawcy, podejście procesowe, zarządzanie łańcuchem dostaw, zakupy, ISO 9001.

ÜBERWACHUNG UND VERBESSERUNG DER LIEFERANTEN-ARBEIT MIT DER HILFE VON DER SIPOC ANALYSE, PDCA MODELL UND ISO 9001 QMS IN DER SPORTARTIKELINDUSTRIE

ZUSAMMENFASSUNG. Hintergrund: Der zunehmende Wettbewerb auf den globalen Märkten und die Erwartungen der Kunden zwangen das Unternehmen, um die Leistung ihrer Lieferanten, die einen Teil ihrer Lieferkette sind, zu verbessern. Die Sportartikelindustrie ist eine Industriebranche, die sehr abhängig von Lieferanten ist, und zusätzlich besteht hauptsächlich aus kleinen Unternehmen mit begrenzen Ressourcen. Deshalb, sehr wichtig ist, eine einfache kostengünstige und ergebnisorientierte Arbeitsweise zu entwickeln.
Methoden: Der Artikel präsentiert die Rahmen von der Methode für die kontinuierliche Verbesserung und Überwachung der Leistung von den Lieferanten (SPMI) und besteht aus folgenden Teilen. In der Erste, werden die Verbesserungsmethoden durchgeschaut und mit den Grundkonzepten vergleicht. Dann sind sie erklärt, basierend auf die Literatur. In den dritten und vierten Teilen ist die Methodologie von SIPOC Analyse und PDCA Methode, wie auch ISO 9001 und 2008 QMS, diskutiert. Die Ergebnisse sind in dem Bespiel vorgestellt.
Ergebnisse: Der bestehende Prozess von der Verbesserung und Überwachung der Leistung von den Lieferanten wurde mit der Hilfe von SIPOC Analyse, PDCA Cycle und ISO 9001 definiert und zugeordnet und anschließend analysiert, um die Problemen, Variationen und unnötige Aktivitäten zu identifizieren. Die korrigierten Maßnahmen wurden empfohlen um den

Problemen zu behandeln. Der verbesserte und überarbeitete Prozess von der Verbesserung und Überwachung der Leistung von den Lieferanten wurde vorgeschlagen.
Fazit: Jede Organisation muss eine geeignete Kombination und Auswahl von hochwertigen Werkzeugen, Methoden und Techniken nutzen, um die kontinuierliche Qualitätsverbesserung zu führen. Diese Rahmen sind eine Leitung für alle, die ein System von der Verbesserung und Überwachung der Leistung von den Lieferanten in Sportartikelindustrie in kleinen und mittleren Unternehmen entwickeln will.

Codewörter: Verbesserung der Lieferantleistung, Prozessbeziehung, Lieferketteverwaltung, Beschaffung, ISO 9001

S. Parkash
Singhania University,
Pacheri Bari Rajasthan, India
e-mail: spk1972@gmail.com

Dr. Veerender Kumar Kaushik
Head Of School Of Management
of the Technological Institute of Textile & Sciences,
Bhiwani, Haryana, India
e-mail: veerenderk_kaushik@rediffmail.com

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 2

http://www.logforum.net

POSSIBLE APPLICATIONS OF INSTRUMENTS OF MEASUREMENT OF THE CUSTOMER VALUE IN THE OPERATIONS OF LOGISTICS COMPANIES

Filip Januszewski

Poznan School of Logistics, Poznan, Poland

ABSTRACT. Background: The growing popularity in recent years of marketing concepts of putting clients in the centre of the interest of companies as well as easy access to data related to customers' behaviors led to the increase of the importance of such concepts as the profitability and the value of the customer. But the customer value in not an unequivocal concept. It can be defined and measured individually depending on the needs of a company, an industry character, objectives or a time horizon.
Methods: The following, most often used, methods for measuring customer value were selected, described and analyzed from the point of view of their usefulness: different types of the portfolio method (e.g. two-steps and three-steps one, nine-field matrix, etc), multidimensional analysis of customers, analysis of the rentability of customers, model PCV, ABC method, RFM method and CLV indicator.
Results: The advantages and disadvantages of each of analyzed methods were presented and evaluated. The possible use of each of the methods was presented and discussed. In the sector of logistics companies, the measurement of the customer value can be an effective tool in managing the customer relationships and in increasing their profitability. Since there is no only one universal way of measuring the customer value, which is appropriate for every selected industry branch, the choice of a particular method depends on many factors, such as a business profile or number of clients served by a company.
Conclusions: The aim of the identification of key customers is to facilitate the optimal allocation of resources of the company. Not all customers are equally important for the company, and the company is not able and should not try to acquire and satisfy needs of each customer.
It should be remembered, that the evaluation of the customer value in logistics companies should not be restricted to only one of discussed methods. The analysis presented in this paper indicates, that the verification of obtained results should be made simultaneously by the use of a few methods not only one of them. The logistics company can successfully use portfolio methods in the combination with such indicators like CLV, PCV or RFM. The multidimensional analysis helps the customer management and can increase the value of the whole company.

Key words: customer value, customer profitability, customer lifetime value, customer portfolio.

INTRODUCTION

The growing popularity in recent years of marketing concepts of putting clients in the centre of the interest of companies as well as easy access to data related to customers' behaviours led to the increase of the importance of such concepts as the profitability and the value of the customer [Fader, Hardie, Lee 2005]. The companies begin to treat their customers more and more as a core element of their financial assets [Keiningham, Aksoy, Bejou 2006]. The managers are aware of the fact, that like in the case of other assets, the customer value is to be measured, maximized and managed in order to maximize the value of the company. The knowledge of the customer value and its importance for the

Citation: Januszewski F., 2011, Possible applications of instruments of measurement of the customer value in the operations of logistics companies. LogForum 7, 4, 2
URL: http://www.logforum.net/vol7/issue4/no2
Accepted: 06.09.2011, on-line: 5.10.2011.

whole company can facilitates decision making related to investments in customer relationships. The management of measureable assets is more profitable, because it allows to make decisions based on concrete facts and data and not only on subjective opinions [Blattberg, Getz, Thomas 2001].

The customer value in not an unequivocal concept. It is often defined as the difference between the incomes and costs generated by that customer. It can be determined based on information of past or anticipated transactions [Grzegorczyk 2007]. The customer value can be defined individually depending on the needs of a company, an industry character, objectives or a time horizon. The companies calculate it both for the entire population of customers, selected segments as well as for individual units.

The measurement of the customer value should be a continuous process. It requires a comprehensive approach from the organization and must involve several steps, such as the identification of customers, their diversification from the point of view of selected criteria, interactions aimed at understanding of customer's needs and then the continuous adjustment of the offer to its requirements and the help in generating profits, which are more and more satisfying for the company [Dobiegała-Korona 2002]. The determining of the customer value as well as the managing of it should be supported by the regularly updated databases of customers. The information used there should be collected continuously and their sources, beside CRM systems, should be additionally the market researches, information obtained during direct contacts and even complains, requests and remarks provided by the customers.

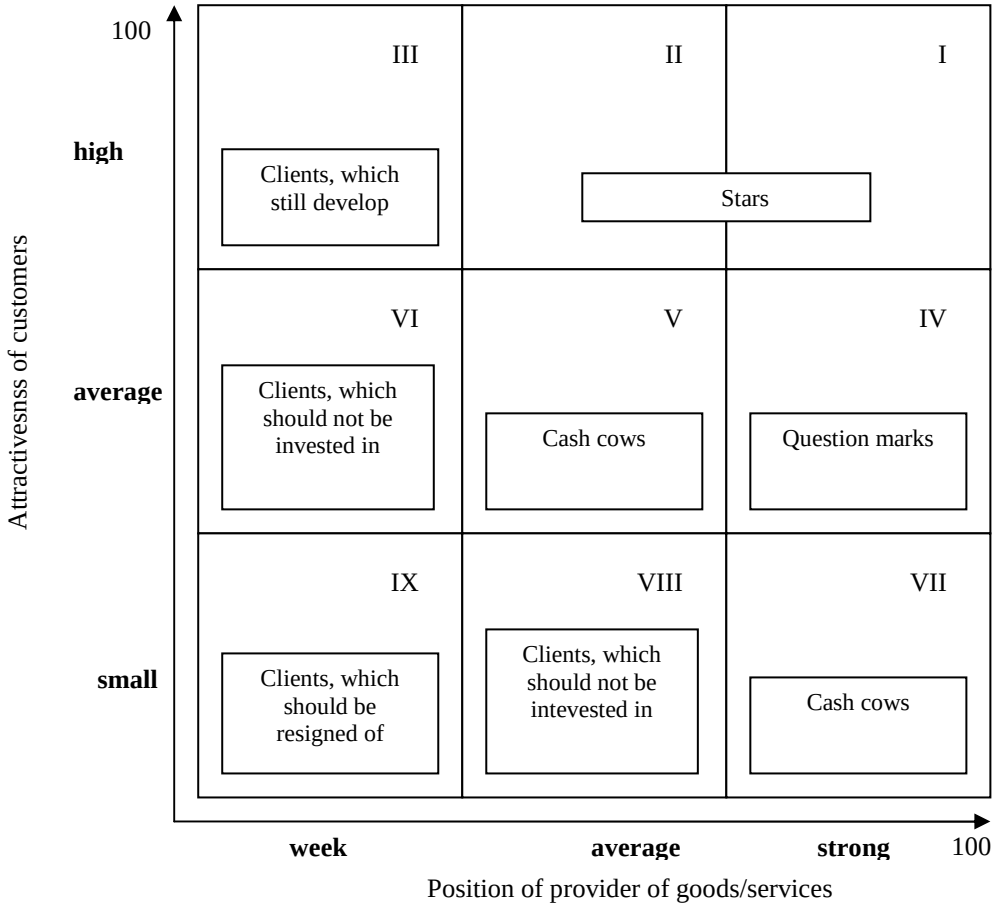
The logistics companies, which commonly use already mentioned CRM tools, can successfully use various methods of the measurement of the customer value. However, it should be noted, that there is no optimal tool to determine this value and the choice of a method should reflect the particular needs of a company, the possible access to the information as well as the external conditions occurring in the selected branch. Taking into consideration these aspects, the range of instruments was tried to be pointed out, which obviously is not the complete set of existing methods. Although, taking into account the specifics of logistics services, the proposed range seems to be the most appropriate one. The aim of this paper was to check the usefulness of selected methods of measurement of the customer value for companies of logistics branch as well as the selection of the most appropriate one among them.

THE DESCRIPTION AND THE ANALYSE OF MEASUREMENT METHODS

The first of described here methods, which are very helpful to differentiate customers in terms of their values, are so called portfolio methods. They derive directly from portfolio theories, used for making decisions connected with capital investments [Yorke, Droussiotis 1994]. The portfolio methods were used in clients' management for the first time in the early 80s. The essence of these methods is based on two-dimensional differentiation of customers in terms of selected characteristics, which are significant for a company.

The two-steps analysis of the customer portfolio described by R.Fiocce, is one of the most common methods used among companies of the logistics branch. This method divides customers by the use of such criteria as difficulties in management of relationships with them, their importance for the company, the attractiveness of the buyer as well as the strength of the relationship binding the business partners. The three-steps analysis of Campbell and Cunnigham [1993] is another portfolio method, created to satisfy the needs of industrial markets but which could find also applications on the market of logistics services. Its first phase consists of assignment of customers to one of four groups: yesterday's clients, today's regular clients, today's special clients and tomorrow's clients. The criteria of this assignment are the sales volume and the use of strategic resources. Then, the measurement of portfolio share of each customer is made taking into account its expenditures of competitive companies. The last step is the proper portfolio analysis, focused only on key customers of the company, taking into consideration their attractiveness and the strength of the relationship.

The nine-field matrix is another method proposed by P.Schmoller [2001], which could support to determine the attractiveness of clients of logistics companies. The attractiveness of the client is also considered in this approach, but instead of the strength of the relationships between a client and a provider, the main focus is put on the bargaining position of the latter. In the process of determining of the client's attractiveness such aspects are taken into account as the size of orders, the potential growth, the bargaining power, the share in the turnover, the loyalty and the willingness to cooperate. The length of the cooperation with a client, the customer satisfaction, the number of long-term orders or the image of the company are taken into consideration in the assessment of the position of the provider (Fig. 1). Like the previously described methods, the matrix helps to classify each client to the appropriate strategic groups. This method is clear and easy to analyze. Its drawbacks are the dependence on the selected evaluation criteria, the relativity, the stability and the focus on the mean values.



Source: Schmoller [2001].

Fig. 1. Matrix of the attractiveness of customer – the position of the provider
Rys. 1. Macierz atrakcyjności klienta – pozycja dostawcy

The other frequently used portfolio method is a model, where the attractiveness of the customer is considered in terms of two factors, directly connected with relations – costs and revenues generated by each customer [Kotler, Armstrong, Saunders 1999].

Despite of undoubted advantages resulting from the simplicity of the use as well as the arbitrariness in the selection of criteria, the portfolio analysis are not without disadvantages. There are opinions, they are only the visualization of the problem and not a specialized analytical tool, providing answers to questions about allocation of resources and facilitating the formulation of a strategy [Yorke, Droussiotis 1994]. Regardless of negative opinions about portfolio analysis, they can provide an excellent starting point for logistics companies for the evaluation of customers by the use of other more specialized methods.

The individual multidimensional analysis of customers is another approach to identifying customer value [Krafft 2007]. This method is a kind of the development of a portfolio analysis. It involves creating the set of criteria, significant for a company and describing its customers and assigning them rating values according to previously approved scale (1-5). The number of specified criteria is not important but their actual importance for a company is really important. The multidimensional look at a company is the greatest advantage of this approach. Due to the necessity of the individualization of this tool, logistics companies should appropriately create the set of criteria describing their clients. However, such approach, based on subjective judgments of managers, creates the danger of the selection of unimportant criteria, which can lead to wrong results.

The another method of the identification of the customer value, which could be implemented in the logistics branch, is the analysis of the rentability of customers. It is understood as the balance of revenues and costs generated by each client. This method, although seems relatively easy to be used, gives some problems in practice. Logistics companies, which are able relatively easily to determine individual variable costs connected with customer services, cannot forget about costs of the customer acquisition and the marketing communication. Already mentioned CRM systems meet the needs of managers and greatly facilitate the access to data [Wallenburg 2009].

The model PCV (past customer value) is another method, which takes into account the past behavior of the customer. The customer value is evaluated on the basis of the history of contacts, but on the contrary to the analysis of the rentability, the value of contacts is discounted according to the formula [Kumar 2008]:

$$PCV = \sum_{t=i}^{T} GC_{it} \times (1+r)^{t}$$

where:

i - client's number,

r - discount rate applied,

T - number of periods preceding the current one,

GC - client's margin for transaction *i* in period *t*.

The ABC method is another method, which groups partners on the basis of the history of their behaviors. It uses the concept created previously for the purpose of analyzing the concentration of incomes. This method uses the Pareto principle. The basis of it is the statement, that 20% elements of analyzed population represent 80% of the accumulated value of the characteristics [Śliwczyński 2007]. The customers of a company are divided in three groups (A, B and C), where the criterion is their share in the turnover generated for the company. The first group consists of 20% of customers generated 80% of incomes, which are the most important clients for the company from the economic point of view. This group requires a special attention. The second group (B) consists of 30-35% of customers, which give app. 15% of the accumulated value. The last group includes 45-50% of customers, which give app. 5% of the accumulated value. The logistics companies, which updated regularly incomes, received from each customer, are able to use this tool even without implementation of special analytical softwares or complex databases.

The RFM (recency, frequency, monetary) method is one of the most widely used indicators for evaluating of customers of a company, applied already for years for the segmentation in the direct marketing [Keiningham, Aksoy, Bejou 2006]. The customer value is calculated there based on previous purchasing behaviors of each customer. Based on internal date of a company, three values are determinated for each of them: recency (time since the last purchase), frequency (of purchase during the analyzed period) and monetary (the total value of purchases made by a customer in the analyzed period). The appropriate weights are assigned to each value and based on that, the customer value is calculated by the use of the formula:

$$RFM = (r \times weight) + (m \times weight) + (f \times weight)$$

where:

r - time since the last purchase,

m - total value of all purchases,

f - frequency of purchases in the analyzed period.

The short time since the last purchase, high frequency of purchases as well as big values of purchases is the characteristics of the most desirable customer from the point of view of a company. The crucial part of RFM method is the proper determination of weights assigned to the variables. It is made based on previous experiences, using heuristic methods or simple regression techniques [Kumar 2008]. The inappropriate selection of weights can result in too subjective assessment of the customer value, leading to wrong conclusions and useless indicators [Kozielski 2006].

The simple way of calculation as well as easy access to necessary data are the most important advantages of RFM method. Additionally, the implementation of RFM method requires no complex analysis, sophisticated software or specialist marketing and statistics knowledge. The RFM indicator can be used by the logistics companies offering a diverse range of services and supporting customers at periodical rate. Otherwise, the dominant factor determining the customer value becomes only the total value of all transactions.

The method, determining the CLV indicator (customer lifetime value) is another, one of the most sophisticated, tool supporting the process of evaluating customers. The customer value in this method is equal to present value of future cash flows attributed to the relationships with the client [Pfeifer, Haskins, Conroy 2005]. This method is based on the method of discounting cash flows used in financial management. It can be used to determine the customer value of only one client or the whole segment and takes into account the possibility of the transfer of a client to the competition [Gupta, Lehmann 2006]. This model is ideal for the companies working according to rules of marketing partnerships, which create, develop and maintain long-term relations with customers.

Since all activities are related to specific investment costs, the company should be able to determine their profitability [Ramanathan 2010]. The customer lifetime value is the total value of profits, which the company obtains during the time of the cooperation with individual customers. In case that the relation client-supplier is the one-time, the customer lifetime value is equal to the profit achieved during this one transaction. In case of repeating purchases, this value is equal to the discounted value of all transactions, made with this client. The customer lifetime value is calculated for fixed periods, according to the formula [Kozielski 2006]:

$$CLV = \frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + ... + \frac{C_n}{(1+k)^n}$$

where:

C_i - profits provided by client in the period i,

$(1+k)^2$ - discount rate for year *i*,

k - cost of capital.

The fixed time of cash flow is taken for calculations, identical for each period. The model applies only to customers engaged in transactions with the company. It ignores the past and future customers and costs of obtaining them. The choice of time of cash flow or the randomness of the process of the purchase is also not included in this method. The cost of a capital needed for calculation of discount rate in subsequent years is set at the required rate of the return of the invested capital. The required rate of return shows the engagement of funds in the project. From the point of view of the owner, such factors like the inflation, return on the free-risk investment as well as the risk of the commitment of resources should be taken into consideration in this method as well. The entrepreneur is willing to invest funds only when the effects of the projects are at least equal to costs of capital.

Another model used to calculate the customer value is the model proposed by S.Grupta, D.R. Lechmann and J.A. Sturat [Dobiegała-Korona 2006]. This model takes into consideration life cycles of various groups of clients and indicators of rotations and is based on the assumption, that any company both attracts and loses clients throughout the whole period of its market activities. In this case the customer value is calculated according to the formula:

$$CLV = \sum_{k=0}^{\infty} \frac{n_k}{(1+i)^k} \sum_{t=k}^{\infty} m_{t-k} \frac{r^{t-k}}{(1+i)^{t-k}} - \sum_{k=0}^{\infty} \frac{n_k c_k}{(1+i)^k}$$

where:

k - period of life of various groups of clients having different life cycles,

n - number of customers acquired in subsequent periods,

i - discount rate,

t - time period analyzed,

m - income generated by the client in time *t*,

r - indicator of client's rotation,

c - cost of the acquisition per client.

The starting point of the model is to determine the values of each group of customers, which were distinguished by their life cycles. Then, the values of all present and future clients are summarized. Each customer generates the income *m* during the period *t*, and the future incomes can be discounted for the present period by the use of the discount rate [Dobiegała-Korona 2006].

Using of CLV indicator requires, in both discussed cases, the knowledge of such concepts like the value of money in time, net present value and the discount rate. The logistics companies, while using the life value, must also have databases containing information on past transactions of customers, margin levels in each case, operating costs or expenses on customer's acquisition.

SUMMARY

The aim of the identification of key customers is to facilitate the optimal allocation of resources of the company. Not all customers are equally important for the company, and the company is not able and should not try to acquire and satisfy needs of each customer. It should be mentioned, that the departure of a non-profit client is beneficial for the company, because expenses on keeping of unprofitable customers are unprofitable.

Many logistics companies identify the value of their customers by the use of the profit generated by them in the past. However, it should not be ignored, that the previous behaviour of clients does not need to repeat in the future. There are also other factors, which should decide about the attractiveness of customers and the key factor should be the probability of a success thanks to contacts with that customer. The criteria of their attractiveness should be precised very clearly at the process of the identification of key clients. They can vary, depending on the size of a company, a market, where it operates or an industry.

Definitely, the customer value should be taken into consideration in the management of relationships with business partners in the present turbulent environment. The incomes and costs of the service, generated by clients as well as the nature of relationships with them influence the final success of the company.

It should be remembered, that the evaluation of the customer value in logistics companies should not be restricted to only one of above described methods. The analysis presented in this paper indicates, that the verification of obtained results should be made simultaneously by the use of a few methods not only one of them. The logistics company can successfully use portfolio methods in the combination with such indicators lie CLV, PCV or RFM. The multidimensional analysis helps the customer management and can increase the value of the whole company.

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ANALIZA PORÓWNAWCZA INSTRUMENTÓW POMIARU WARTOŚCI KLIENTA W DZIAŁALNOŚCI PRZEDSIĘBIORSTW LOGISTYCZNYCH

STRESZCZENIE. **Wstęp**: Wzrost popularności koncepcji marketingowych stawiających klienta w centrum zainteresowania przedsiębiorstwa, jak również łatwy dostęp do danych związanych z zachowaniami konsumentów, przyczynił się do wzrostu znaczenia takich koncepcji jak zyskowność czy wartość klienta. Ale pojęcie wartości klienta nie jest jednoznacznym pojęciem. Może być mierzony przy wykorzystaniu różnorakich instrumentów w zależności od potrzeb przedsiębiorstwa, charakteru branży czy horyzontu czasowego.
Metody: Następujące, najczęściej stosowane metody pomiaru wartości klienta zostały wybrane, opisane oraz ocenione z punktu widzeniu ich przydatności: różnego rodzaju analizy portfelowe (dwustopniowa, trzystopniowa, macierz 9-polowa, itd.), wielowymiarowa analiza klientów, analiza rentowności klientów, model PCV, metoda ABC, metoda RFM oraz CLV.
Wyniki: Zalety i wady każdej z analizowanych metod zostały zaprezentowane i poddane ocenie. Dyskusji poddano przydatność każdej z nich. W sektorze przedsiębiorstw logistycznych pomiar wartości klienta może okazać się skutecznym narzędziem w zarządzaniu relacjami z klientem i skutecznie zwiększyć ich zyskowności. Ponieważ nie istnieje jeden uniwersalny sposób pomiaru wartości klienta, odpowiedni dla wybranej branży, o wyborze konkretnej metody decyduje wiele czynników, takich jak profil działalności, czy liczba klientów obsługiwanych przez przedsiębiorstwo.
Wnioski: Celem identyfikacji kluczowych klientów jest ułatwienie procesu optymalnej alokacji zasobów przedsiębiorstwa. Nie wszyscy klienci są tak samo istotni dla przedsiębiorstwa i przedsiębiorstwo nie powinno próbować zaspokoić potrzeb każdego z klientów. Należy pamiętać, że ocenę wartości klienta nie należy dokonywać w oparciu o tylko jedną z omawianych metod. Przedstawiona analiza wskazuje, że ocena otrzymanych wyników powinna być dokonana przez zastosowanie równolegle kilku metod, a nie tylko jednej z nich. Firmy logistyczne mogą z powodzeniem stosować metody portfelowe w połączeniu z takimi wskaźnikami jak CLV, PCV czy RFM. Wielowymiarowa analiza wspomaga proces zarządzania klientami oraz przyczynia się do wzrostu wartości całego przedsiębiorstwa.

Słowa kluczowe: wartość klienta, rentowność klienta, wartość życiowa klienta (customer lifetime value), portfel klientów.

VERGLEICHSANALYSE DER INSTRUMENTE ZUR VERMESSUNG DER KUNDENWERT VON LOGISTISCHEN UNTERNEHMEN

ZUSAMMENFASSUNG. Hintergrund: Die, in den letzten Jahren, wachsende Popularität von Marketing-Konzepten um Kunden in den Mittelpunkt des Interesses von Unternehmen zu setzen, sowie der einfache Zugang zu Daten über Kundenverhaltensweisen führte zu der Zunahme der Bedeutung von solchen Konzepten wie die Kundenrentabilität und der Kundewert. Aber der Kundewert ist nicht ein eindeutiger Konzept. Es kann individuell nach den Bedürfnissen des Unternehmens, der Branche, der Ziele oder der Zeithorizont definiert und gemessen werden.
Methoden: Die folgenden, am häufigsten verwendeten, Methoden zur Messung der Kundenwert wurden ausgewählt, beschrieben und aus der Sicht ihrer Nützlichkeit analysiert: verschiedene Arten der Portfolio-Methode (z. B. Zwei-Stufen und Drei-Stufen, 9-Felder-Matrix, etc.), multidimensionale Analyse von Kunden, die Analyse der Rentabilität von Kunden, PCV-Modell, ABC-Methode, RFM-Methode und CLV-Anzeige.
Ergebnisse: Die Vorteile und Nachteile von jeder von den analysierten Methoden wurden vorgestellt und bewertet. Die möglichen Verwendungen der vorgestellten Methoden wurden präsentiert und diskutiert. Die Messerung des Kundenwertes in der Branche der logistischen Unternehmen kann sehr effektives Werkzeug sein, die hilft in der Verwaltung von Kundenbeziehungen wie auch steigert effektiv die Rentabilität. Es gibt keine universalle Methode zur Messung der Kundenwert in einer ausgewählten Branche. Die Auswahl von der Methode ist deshalb abhängig von vielen Faktoren wie z.B. Unternehmensprofil oder die Zahl der Kunden.
Fazit: Das Ziel der Identifizierung von wichtigen Kunden ist die optimale Allokation der Ressourcen des Unternehmens zu erleichtern. Nicht alle Kunden sind genauso wichtig für das Unternehmen, und das Unternehmen ist nicht in der Lage und sollte nicht Bedürfnisse jedes einzelnen Kunden befriedigen versuchen. Die Bewertung von dem Kundenwert in den logistischen Unternehmen sollte nicht nur auf eine Methode eingeschränkt wird. Die, in diesem Artikel präsentierte Analyse, zeigt dass die Überprüfung der erzielten Ergebnisse gleichzeitig durch die Verwendung von nicht eine aber einigen verschiedenen Methoden gemacht werden sollte. Die logistischen Unternehmen können erfolgreich die Portfolio-Methoden in der Kombination mit solchen Indikatoren wie CLV, PCV oder RFM nutzen. Die multidimensionale Analyse hilft bei dem Kundenverwaltung wie auch
der Erhöhung des Wertes des gesamten Unternehmens.

Codewörter: Kundenwert, Kundenrentabilität, Kundenlebenswert (Customer Lifetime Value), Kundenportfolio.

Filip Januszewski
Katedra Ekonomii i Marketingu
Wyższa Szkoła Logistyki w Poznaniu

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 3

http://www.logforum.net

CHARACTERIZATION OF SMALL AND MEDIUM ENTERPRISES (SMES) OF POMERANIAN REGION IN SIX SIGMA METHODOLOGY APPLICATION

Piotr Grudowski, Piotr Waszczur

Gdansk University of Technology, Gdansk, Poland

ABSTRACT. **Background:** Six Sigma is related to product's characteristics and parameters of actions, needed to obtain these products. On the other hand, it is a multi-step, cyclic process aimed at the improvements leading to global standard, closed to the perfection. There is a growing interest in Six Sigma methodology among smaller organizations but there are still too little publications presented such events in the sector of small and medium enterprises, especially based on good empirical results. It was already noticed at the phase of the preliminary researches, that only small part of companies from this sector in Pomerian region use elements of this methodology.

Methods: The companies were divided into groups by the type of their activities as well as the employment size. The questionnaires were sent to 150 randomly selected organizations in two steps and were addressed to senior managers. The questionnaire contained the questions about basic information about a company, the level of the knowledge and the practical application of Six Sigma methodology, opinions about improvements of processes occurring in the company, opinions about trainings in Six Sigma methodology.

Results: The following hypotheses were proposed, statistically verified and received the answer:

- The lack of the adequate knowledge of Six Sigma methodology in SMEs limits the possibility to effectively monitor and improve processes - accepted.
- The use of statistical tools of Six Sigma methodology requires the broad action to popularize this knowledge among national SMEs - accepted.
- The level of the awareness of the importance as well as practical use of Six Sigma methodology in manufacturing SMEs is higher than in SMEs providing services - rejected, the level is equal.
- The level of the knowledge and the use of Six Sigma methodology in medium manufacturing companies is significantly higher than in small manufacturing companies - accepted.
- The level of the knowledge and the application of elements of Six Sigma methodology in SMEs is positively appreciable by these companies, which implemented the QMS -accepted.
- SMEs prefer to improve already existing processes rather than radically to redesign them in order to reduce the inconstancy - accepted.

Conclusions: The level of the knowledge of tools and techniques of Six Sigma methodology in SMEs in Pomeranian region is low and requires a broad popularization action. The level of the awareness of the significance as well as the practice of the use of Six Sigma methodology in manufacturing companies is not significantly different from that one in companies providing services, but it is higher in medium ones in comparison to smaller ones. The introduction of QMS has also a positive influence on this level. The companies of this sector prefer to improve processes rather than to redesign them.

Key words: Six Sigma, small and medium enterprises, researches.

Citation: Grudowski P., Waszczur P., 2011, Characterization of small and medium enterprises of Pomeranian region in Six Sigma methodology application. LogForum 7, 4, 3
URL: http://www.logforum.net/vol7/issue4/no3
Accepted: 06.09.2011, on-line: 5.10.2011.

INTRODUCTION

The concept of Six Sigma, which continuously gains in the importance, derives from theories, which put the strong emphasis on the role of a process in the management of organization. On the one hand, Six Sigma is the synonym of the highest global standard and is related to product's characteristics as well as parameters of actions, needed to obtain these products [George 2003, Truscott 2003]. On the other hand, it is a multi-step, cyclic process aimed at the improvements leading to already mentioned standard, closed to the perfection [Truscott 2003]. Although the elements of Six Sigma are successfully implemented in big organizations, both production and service ones, there are still too little publications presented such events in the sector of small and medium enterprises, especially based on good empirical results [Antony, Kumar, Madu 2005; Wiele, Brown 1998; Wessel, Burcher 2004, Brun 2011, Bratić 2011].

There is a growing interest in Six Sigma methodology among smaller organizations, which should seem to be understood due to the fact, that they are also the suppliers of bigger organization, operating on the global market [Kumar, Antony, Douglas 2009]. At the same time, the big companies, due to growing demands of their customers, cooperate with those suppliers, who are able to meet successfully those expectations [Dominiak 2005, Wessel, Burcher 2004].

As a part of the research project of the Ministry of Science and Higher Education entitled "The group implementation of selected elements of the Six Sigma concept in small an medium enterprises of Pomeranian Region", the Authors conducted a study, aimed to identify the problems and needs related to the knowledge and the practical implementation of this concept. The results have to give the answer, whether it is justified to introduce this methodology in smaller organizations as well as to determine the scope of this implementation. Due to the specific character of researched area (SMEs), there is a need to develop the appropriate implementation concept of Six Sigma, the methods so far used and implemented successfully in big companies.

Key results and conclusions are presented in this paper, which can be the basis to develop the appropriate methodological recommendations.

THE AIM OF THE RESEARCH

The aim of these researches was to identify the level of the knowledge and the implementations of Six Sigma concept in the monitoring and improving of processes in small and medium enterprises of Pomeranian Region. As it was already noticed at the phase of the preliminary researches, only small part of companies from this sector use elements of this methodology. A lot of respondents from this sector do not see the need for a methodical approach to monitoring and improving of processes and act more intuitively [Grudowski 2006].

CHARACTERISTICS OF TESTED SAMPLES

The study was conducted in the period from December 2009 to September 2010. In order to identify the receivers of the questionnaires, the procedure of layer samples was implemented, using the previously verified address database. The companies were divided into groups by the type of their activities (production, service, and mix) as well as the employment size (up to 10 persons, 11-50 persons, 51-250 persons). The questionnaires were sent in two steps and the mailing was renewed in case of the absence of a response in the expected period.

The questionnaires were sent to 150 randomly selected organizations by post mail (together with the return envelope), e-mail or passed in person.

The covering letter was attached to the questionnaires, which explained the purpose of this study. The anonymity of the respondents was reserved. The questionnaires were addressed to senior managers. In case the company has a normative management system, the questionnaires were addressed to managers responsible for the management system, in other cases – to production managers or chief executives.

The complete responses were obtained from 36 subjects (24%). There was additionally 8 mail returns, due to the shutdowns or the address change of the company.

RESEARCH METHODOLOGY

The questionnaire contained the questions about:

1. basic information about a company (number of employees, type of the activity, normative management systems introduced in a company),
2. the level of the knowledge and the practical application of Six Sigma methodology,
3. opinions about improvements of processes occurring in the company,
4. opinions about trainings in Six Sigma methodology (this part of research will be presented in the separate paper).

The assessment of the quality of the scale used in the questionnaire was necessary before the statistical analysis could be conducted. For this purpose, the assessment of the reliability and the validity of the scale were carried out. This scale was developed for two parts of the questionnaire, i.e. "Knowledge and application of Six Sigma methodology" and "Opinions about the improvement of processes in the company".

The reliability of the scale determines the precision of the research tool, in this case - of the multi-position measuring scale, to provide the exact data. The reliability is formally defined as the proportion of the variance of true results to the variance of results obtained. The measurement is reliable if the results obtained by the use of the scale are the same or similar in the subsequent measurements.

The internal consistency method, using α-Cronbach coefficient is commonly used to verify the reliability of designed measurement scales used to estimate the responses of questionnaires. This method allows determining the extent to which the elements forming the scale are correlated and consistent with the measurement of the concept represented by them.

The value of the α-Cronbach coefficient is between 0 and 1. The values over 0,7 show the high reliability of the scale [Saraph, Benson, Schroeder 1989].

The calculations were conducted by the use of the appropriate procedure of the STATISTICA package. The obtained value of α for the adopted scale of the research tool was 0,83, which means that the scale is reliable. The values of α-Cronbach coefficient were determined according to the rule: "whether the α coefficient for the scale will increase, if the element having the weakest correlation with the scale is eliminated?" It was found that the average correlation among all elements of the scale (aspects of process approach) was close to 0.6, each element had similar contribution to the reliability of the scale and removing one of them would reduce the value of the α coefficient and thereby reduce the reliability of the scale.

The validity of the measurement scale means its ability to give information about the factor, which is measured. It informs also whether the goal of the measurement process was reached or not. The measurement scale can be reliable and not accurate but it cannot be accurate without being reliable. Therefore, the reliability should be regarded as the necessary condition of the validity and not only the sufficient one.

The assessment of the validity of the scale designed to measure the responses, was conducted according to the approach described by Saraph, Benson and Schroeder [1989]. The following types of validities were taken into consideration:

- content validity,
- criterion validity and
- construct validity.

The content validity is the subjective and systematic evaluation, whether the measurement scale covers the scope of the measured object. The criterion validity gives information, how the result of the measurement is consistent with the other criterion, related to the impact of the measured characteristics, whether the results obtained by the used of given tool can be confirmed by the use of any other measurement tool. The multiple regression was used to confirm numerically the criterion validity.

The construct validity is the most important one. It determines the degree, to which the scale adopted for the study, estimates the construct (the methodology of Six Sigma). The factor analysis is the most commonly used approach to confirm whether the adopted scale has the proper construct validity. It is estimated, whether the measurement scale is one-dimensional and whether all items of the scale make significant contribution to define the construct. In case the scale is not one-dimensional, it cannot be used to assign aggregated numerical measure, obtained from averaging marks of its individual aspects, to a construct. So called factor loadings, calculated as a result of factor analysis, indicate the saturation ratio by this factor and the correlation coefficients of a variable with other factors.

The application of proper analytical procedures confirmed the required quality of the measurement scale and therefore allowed to use the results obtained.

The analysis of results of the questionnaires was made by the use of STATISTICA and MS Excel softwares. The following calculations of results were conducted:

- normal distribution of random variables by the use of Shapiro-Wilk test,
- verification of the homogeneity of variance by the use of Brown and Forsyth test,
- verification of parametric statistical hypotheses by the use of:
  - t-test of differences of mean values for independent samples,
  - t-test for mean values, right-side,
- the significant level α=0,05 was assumed for all above mentioned tests.

RESULTS

Tables 1 and 2 present the characteristics of respondents.

Table 1. Types of surveyed companies by the type of the activity
Tabela 1. Podział badanych przedsiębiorstw ze względu na rodzaj działalności

Type of activity	Number of companies	Share % in the sample
service	6	17
service and production	9	25
production	21	58

Source: own work

Table 2. Types of surveyed companies by the size of the employment
Tabela 2. Podział badanych przedsiębiorstw ze względu na wielkość zatrudnienia

Number of employees	Number of companies	Share % in the sample
<10 (micro companies)	3	8
11÷50 (small companies)	9	25
51÷250 (medium companies)	24	67

Source: own work

The level of the knowledge and practical application of Six Sigma methodology

The primary aim of this study was to determine the extent to which the respondents are familiar with and make the use of elements of Six Sigma methodology. Preliminary tests conducted by Authors indicated that only the standard methods of passive control of products based on the visual assessment or the use of measurement tools were used to monitor operational processes in smaller companies. Only a few of questioned companies used the quality analysis of process capacities and process control supported by statistical analysis of data. As a response to the question related to the use of commonly known methods of the identification of problems or the analysis of data connected with the quality processes, many managers answered that they did not see needs for such methods or they did not have knowledge about it. Many companies operate intuitively, using a brainstorming session as the only method used to improve the processes. It should be noted, they are companies that have certificates of the quality management system (QMS), which requires the use of methods of data analysis.

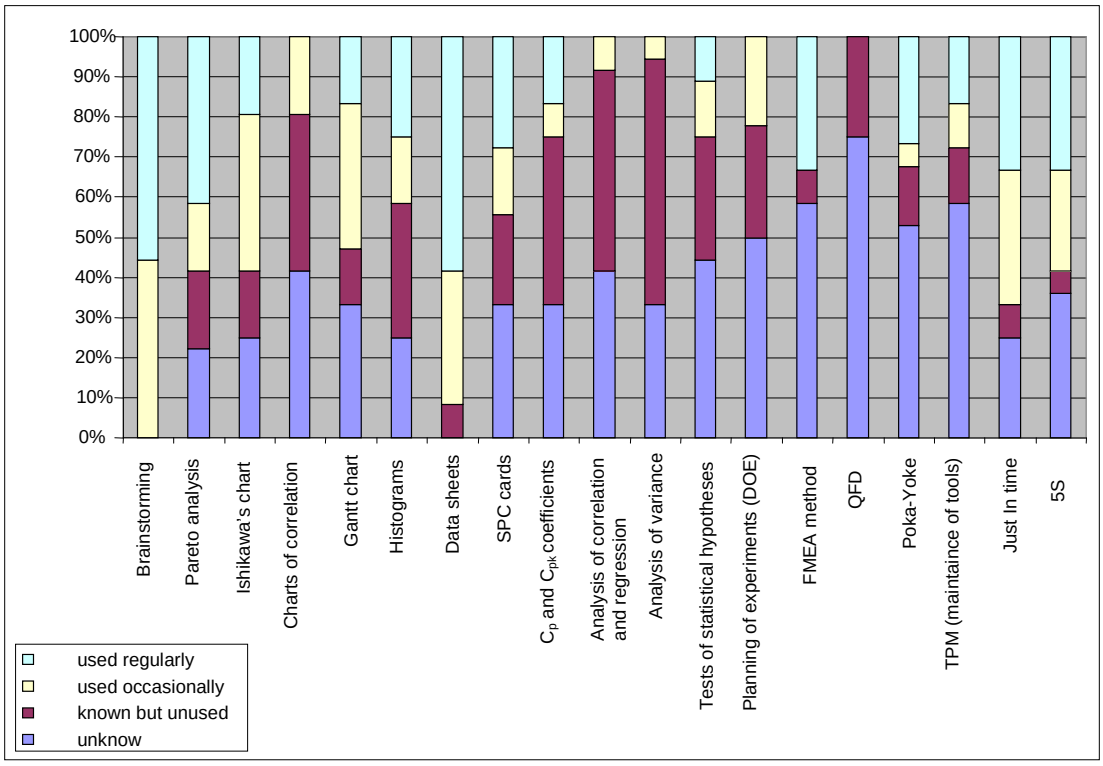
Referring to the results, the following hypotheses were assumed:

Hypothesis 1: The lack of the adequate knowledge of Six Sigma methodology in SMEs limits the possibility to effectively monitor and improve processes.

Hypothesis 2: The use of statistical tools of Six Sigma methodology (control cards, analysis of quality capacity, DoE, ANOVA, correlation and regression) requires the broad action to popularize this knowledge among national SMEs (promotion, free of charge trainings, postgraduate studies, courses, etc). The local authorities, universities and other institutions should be involved in this process.

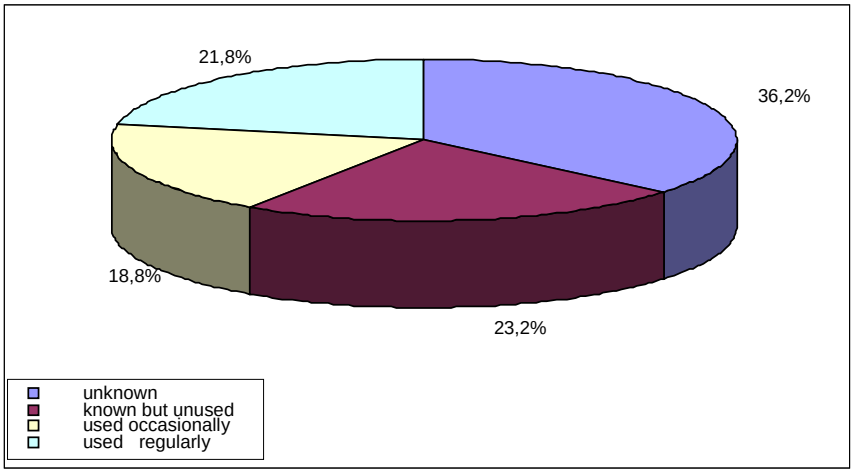
The special set of methods, tools and techniques of Six Sigma was prepared to assess the level of the knowledge and practical use of elements of Six Sigma methodology as well as to verify the proposed hypotheses H1 and H2. The following classification scale was applied: “we do not know”, “we know, but we do not use”, “we use occasionally” and “we use regularly”.

The percentage share of responses of each category is presented in the Figure 1. The conclusion, based on this, can be made, that the knowledge of elements of Six Sigma methodology is very low. There was no answer “we do not know” only in case of two methods: the brainstorming and data sheets. It can be concluded, that every meetings and attempts to solve current problems are considered as brainstorming and MS Excel spreadsheets, used simply to set together data and to prepare graphic presentations of them, are considered to be data sheets. Therefore, it seems reasonable not to take into consideration these responses in the further analysis.



Source: own work

Fig. 1. Percentage shares of responses describing the knowledge and practical application of key methods, techniques and tools of Six Sigma
Rys. 1. Procentowy udział odpowiedzi opisujący znajomość i praktyczne stosowanie kluczowych metod, technik i narzędzi Six Sigma



Source: own work

Fig. 2. Cumulative percentage shares of responses describing the knowledge and practical application of key methods, techniques and tools of Six Sigma
Rys. 2. Skumulowany procentowy udział odpowiedzi opisujący znajomość i praktyczne stosowanie kluczowych metod, technik i narzędzi Six Sigma

The level of the knowledge of other methods, tools and techniques is also very low. The cumulative percentage share of the response "unknown" is very high and is equal to 36,2% (Fig. 2). The representatives of SMEs do not know even the simplest tools like histograms (25% of responses "unknown") or Pareto analysis (22,2%). In case of methods that are even more sophisticated the percentage share of the response "unknown" was even higher and for example, for FMEA method – 58,4% or for QFD – 75%. It should be mentioned there were only three questionnaires, where there was no answer "unknown". The average number of such answers was 6-10. There were two cases, where even 17 responses were "uknown". They were small firms offering services.

The most regularly used methods were: Pareto analysis (41%), FMEA method (33,3%), 5S (33,3%), SPC cards (27,8%) and histograms (25%). It should be mentioned, that these responses were given mostly by the manufacturing companies.

Based on these results, there is no reason to reject the Hypothesis H1. There is no adequate knowledge of Six Sigma methodology among SMEs, which significantly limits the possibility of effective monitoring and improving of processes.

The answer "known but unused" (23,2%) was the next most frequently given answer, which together with answer "unkown" gives nearly 60% of all responses. Therefore, not only the level of the knowledge of Six Sigma methodology is very low in our SMEs but also the level of the use of basic methods available in Six Sigma methodology. Even, if there is not always a need to use a big number of various tools, it can be concluded, that the companies do not use them due to the lack of appropriate formalized approach (guidelines, manuals).

The individual interviews conducted by Authors with the representatives of SMEs indicate that if the SMEs had better prepared staff and received systemically organized assistance in the implementation, supported by examples of benefits of their use, the situation certainly would be improved. Therefore there is no reason to reject the hypothesis H2, since there is a possibility to effectively increase the level of the knowledge and use of Six Sigma methodology thanks to such activities as the promotion of this knowledge, free of charge training, practical workshops organized with the support of local authorities and universities (such solutions can be found already in other countries).

The level of the knowledge and practical application of elements of Six Sigma methodology in SMEs sector

Another part of the questionnaire was to enable to verify following hypotheses:

Hypothesis 3: the level of the awareness of the importance as well as practical use of Six Sigma methodology in manufacturing SMEs is higher than in SMEs providing services.

The null hypothesis to verify the above-mentioned one was assumed as follows:

H3-0: The average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr1}$) in manufacturing SMEs is not different from the average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr2}$) in SMEs providing services, i.e. $x_{śr1} - x_{śr1} = 0$.

The alternative hypothesis was assumed as follows:

H3-1: The average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr1}$) in manufacturing SMEs is higher than the average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr2}$) in SMEs providing services, i.e. $x_{śr1} - x_{śr1} > 0$.

The 5-grade Likert scale was applied to estimate the attitudes of respondents, where the value "1" means "definitely not", the value "3" means "neither yes nor no" and the value "5" means "definitely yes". The positions on Likert scale represent the approximation of normal and interval distribution of the characteristics.

The *t*-test for the differences of means for independent samples (manufacturing SMEs and SMEs providing services) was applied with regards to the knowledge and the practical application of

statistical control of processes, described by 5 aspects. The results of the analysis of data obtained from the verification of the hypothesis H1 are presented in the Table 3.

Table 3. Statistical data for the verification of the hypothesis H3
Tabela 3. Dane statystyczne do weryfikacji hipotezy H3

Knowledge and application of Six Sigma methodology					
manufacturing SMEs (n_1= 21)		SMEs providing services (n_2= 6)		Critical value $t_{0,05;25}$=2,06	Difference significant? yes/no
$x_{śr1}$	s_1	$x_{śr2}$	s_2	*t* value	
4,11	0,42	3,9	0,33	**1,14**	**no**

Source: own work

The results of the analysis indicate, there is no reason to reject the null hypothesis H3-0. It proves that the level of the awareness of the significance as well as the practical application of Six Sigma methods is the same both in manufacturing SMEs and in those, which provide services.

The next hypothesis was related to the size of the organizations.

Hypothesis 4: The level of the knowledge and the use of Six Sigma methodology in medium manufacturing companies is significantly higher than in small manufacturing companies.

The null hypothesis to verify the above-mentioned one was assumed as follows:

H4-0: The average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr1}$) in medium manufacturing companies is not different from the average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr2}$) in small manufacturing companies, i.e. $x_{śr1} - x_{śr1} = 0$.

The alternative hypothesis was assumed as follows:

H4-1: The average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr1}$) in medium manufacturing companies is higher than the average value of the estimation of the knowledge and the use of Six Sigma methodology ($x_{śr2}$) in small manufacturing companies, i.e. $x_{śr1} - x_{śr1} > 0$.

The *t*-test for the differences of means for independent samples (medium manufacturing companies and small manufacturing companies) was applied with regards to the knowledge and practical application of Six Sigma methodology. The results of the analysis of data obtained from the verification of the hypothesis H4 are presented in the Table 4.

Table 4. Statistical data for the verification of the hypothesis H4
Tabela 4. Dane statystyczne do weryfikacji hipotezy H4

Knowledge and application of elements of Six Sigma methodology					
medium manufacturing SMEs (n_1= 15)		small manufacturing SMEs (n_2= 6)		Critical value $t_{0,05;19}$=2,093	Difference significant? yes/no
$x_{śr1}$	s_1	$x_{śr2}$	s_2	*t* value	
4,28	0,38	3,70	0,11	**3,59**	**yes**

Source: own work

The rejection of the hypothesis H4-0 for the benefit of the hypothesis H4-1 indicates, that the level of the knowledge and the application of statistical Six Sigma methodology in medium manufacturing

companies is significantly higher than in the small manufacturing ones. It may indicates, that both the knowledge and the application of Six Sigma methodology is at the higher level due to the facts, they exist already longer and they have stronger cooperation with foreign partners, which use those methods.

In order to determine, whether the implementation of the quality management system (QMS) is connected with the positive assessment of the level of the knowledge and the application of elements of Six Sigma methodology, the following hypothesis was assumed:

Hypothesis 5: the level of the knowledge and the application of elements of Six Sigma methodology in SMEs is positively appreciable by these companies, which implemented the QMS.

The null hypothesis to verify the above-mentioned one was assumed as follows:

H5-0: The average grade on the knowledge and the application of elements of Six Sigma methodology in SMEs, which implemented the QMS, is smaller or equal to 4.

The alternative hypothesis was assumed as follows:

H5-1: The average grade on the knowledge and the application of elements of Six Sigma methodology in SMEs is bigger than 4 ("rather yes" and "definitely yes"), which indicates the positive estimation of the level of the knowledge and the application of elements of Six Sigma methodology in SMEs, which implemented the QMS.

The right-side *t*-test was applied to verify the null hypothesis. The results of the calculations are presented in the Table 5.

Based on values of mean partial estimations, the average value and the standard deviation for them was calculated for the whole construct, the knowledge as well as the application of Six Sigma methodology. The statistical values of tested *t*, calculated in regard to each aspect as well as to the construct, created by them, allow rejecting the hypothesis H5-0 in favor of the alternative hypothesis H5-1, which confirms the positive influence of the QMS implementation on the level of the knowledge and the application of Six Sigma methodology in SMEs.

Table 5. Results of statistical analysis for the verification of the hypothesis H5
Tabela 5. Wyniki analizy statystycznej danych weryfikujących hipotezę H5

The knowledge and the application of Six Sigma methodology					
	$x_{śr}$	s	importance	*t* value	H.5-0 („null")
The knowledge of elements of Six Sigma methodology is at the satisfactory level and brings the benefits	4,43	0,51	1	3,87	reject
The knowledge of elements of Six Sigma methodology is at the satisfactory level and brings the benefits	4,24	0,44	4	2,50	reject

Source: own work

Improvement of business processes in a company

The next part of the questionnaire concerned the improvement of processes. The opinions on that subject had to determine, whether SMEs seek only the improvement of existing processes or they are ready to redesign them in a radical way. In order to verify this opinion, the following hypothesis was assumed:

Hypothesis 6: SMEs prefer to improve already existing processes (DMAIC – "Define, Measure, Analyze, Improve, Control") rather than radically to redesign them (DfSS – "Design for Six Sigma") in order to reduce the variability.

H6-0: The average grade on aspects of process improvement in a company is smaller or equal to 4.

The alternative hypothesis was assumed as follows:

H6-1: The average grade on aspects of process improvement in a company is bigger than 4, when the given aspect is realized in a company.

Based on the assessments of respondents in the questionnaires, the average values and standard deviation were calculated in order to determine their sequence with regard to the assessment of the impact of each of them on the total assessment.

The right-side *t*-test was applied to verify the null hypothesis. The results of the calculations are presented in the Table 6.

Table 6. Results of the statistical analysis of data used for the verification of the hypothesis H6
Tabela 6. Wyniki analizy statystycznej danych weryfikujących hipotezę H6

Opinion about the improvement of processes in the company					
	$x_{śr}$	s	rank	*t* value	H.6-0
1. The formal procedures of the identification of the incompatibility were applied in the company	3,75	0,60	1	7,35	reject
2. The incompatibility of any process are carried out at once	3,67	0,48	2	8,25	reject
3. The identification of incompatibility is connected with the identification and elimination of their reasons	4,33	0,48	4	4,12	reject
4. The improvement of the process consists of the improvement of already existing process	4,44	0,65	3	4,03	reject
5. Extreme redesign of the process takes place after finding the incompatibility	3,69	0,98	5	1,84	accept

Source: own work

As shown in the tables above, the average value below 4 was obtained only in case of the aspect 5. The calculated values of *t*-test statistics for the aspects from 1 to 4, allow rejecting the null hypothesis in favor of the alternative hypothesis. It indicates that the formal procedures to monitor incompatibilities are eliminated at once in the analyzed SMEs (this aspect was evaluated at the highest position). However, in case of the aspect 5, there are no reasons to reject the hypothesis H6-0. It suggests, that the respondents do not decide to radically redesign of the process, in which the incompatibilities were found.

CONCLUSIONS

The following conclusions can be made based on the presented results of the research conducted in SMEs in Pomeranian region:

1. The medium companies of the manufacturing sector, having certified quality management systems, have shown the greatest interest in this study. This fact is positively correlated with the level of the awareness of the need for the application of appropriate methods of monitoring and improving of the process.
2. The level of the knowledge of tools and techniques of Six Sigma methodology in SMEs in Pomeranian region is low and requires a broad popularization action.
3. The level of the awareness of the significance as well as the practice of the use of Six Sigma methodology in manufacturing companies is not significantly different from that one in companies providing services.

4. The level of the awareness of the significance as well as the practice of the use of Six Sigma methodology in medium manufacturing companies is higher than in small manufacturing companies.
5. The representants of SMEs of Pomeranian regions understand the need to improve methodically their process. They focus on improving of their processes rather than on radical redesign of them.

The courses and group training on this topic in SMEs of Pomeranian region are the most favourable form of the learning. Based on the experience of Authors, the companies prefer to choose a form of group trainings, because they allow the exchange of experiences among participants as well as motivate highly to achieve agreed goals.

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CHARAKTERYSTYKA MAŁYCH I ŚREDNICH PRZEDSIĘBIORSTW (MŚP) W ZAKRESIE WYKORZYSTANIA ELEMENTÓW METODYKI SIX SIGMA NA PRZYKŁADZIE REGIONU POMORSKIEGO

STRESZCZENIE. **Wstęp**: Six Sigma jest powiązana z cechami charakterystycznymi dla produktu oraz parametrami działań, potrzebnych do uzyskania tych produktów. Z drugiej strony jest to wielostopniowy powtarzający się proces skierowany na ciągłe udoskonalenia, dążące do globalnych standardów, wręcz do stanu perfekcyjnego. Jakkolwiek wzrasta zainteresowanie metodyką Six Sigma wśród małych i średnich przedsiębiorstw, to jednak nadal w literaturze mało jest

publikacji poruszających temat tej metodyki w sektorze małych i średnich przedsiębiorstw, szczególnie popartych dobrymi empirycznymi wynikami. Wyniki badań wstępnych wskazywały, że tylko niewielka część przedsiębiorstw tego sektora w regionie pomorskim stosują w praktyce elementy tej metodyki.
Metody: Przedsiębiorstwa zostały podzielona na grupy w zależności od typu ich działalności oraz wielkości zatrudnienia. Ankiety, adresowane do kierownictwa przedsiębiorstw, zostały wysłane do 150 losowo wybranych organizacji w dwóch etapach. Ankieta zawierała pytania o podstawowe dane przedsiębiorstwa, poziom wiedzy na temat zastosowań Six Sigma, opinii dotyczących uprawnień w firmie oraz szkoleń w zakresie metodyki Six Sigma.
Wyniki: Poniższe hipotezy zostały zaproponowane i statystycznie zweryfikowane. Uzyskano następujące wyniki:
- brak odpowiedniego poziomu wiedzy o metodyce Six Sigma w małych i średnich przedsiębiorstwach (MŚP) ogranicza możliwość efektywnego monitorowania i usprawniania procesów - hipoteza potwierdzona,
- stosowanie metod statystycznych należących do metodyki Six Sigma wymaga szeroko zakrojonej akcji popularyzującej wiedzę z tego zakresu wśród krajowych MŚP - hipoteza potwierdzona,
- poziom świadomości ważności oraz praktycznego stosowania metodyki Six Sigma w MŚP sektora produkcyjnego jest wyższy aniżeli sektora usługowego - hipoteza odrzucona, poziom jest taki sam,
- poziom wiedzy oraz praktycznego stosowania metodyki Six Sigma w średnich przedsiębiorstwach produkcyjnych jest znacząco wyższy aniżeli w małych przedsiębiorstwach produkcyjnych - hipoteza potwierdzona,
- poziom wiedzy oraz praktycznego stosowania metodyki Six Sigma w MŚP jest pozytywnie akceptowany przez przedsiębiorstwa, które wdrożyły system zarządzania jakością - hipoteza potwierdzona,
- MŚP wolą raczej modyfikować istniejące procesy aniżeli radykalnie je zmieniać w celu ograniczenie w nich nieciągłości - hipoteza potwierdzona.

Wnioski: Poziom wiedzy na temat metod i technik metodyki Six Sigma w małych i średnich przedsiębiorstwach regionu pomorskiego jest niski i wymaga szeroko zakrojonej akcji popularyzującej wiedzę z tego zakresu. Poziom świadomości ważności oraz praktycznego stosowania metodyki Six Sigma w MŚP sektora produkcyjnego nie jest wyższy aniżeli sektora usługowego, ale jest wyższy w średnich przedsiębiorstwach w stosunku do małych. Wdrożenie systemu zarządzania jakością ma pozytywny wpływ na ten poziom. Przedsiębiorstwa z tego sektora preferują usprawnianie procesów aniżeli ich radykalne zmiany.

Słowa kluczowe: Six Sigma, małe i średnie przedsiębiorstwa, badania.

DIE CHARAKTERISTIK DER KLEINEN UND MITTLEREN UNTERNEHMEN (KMU) IM BEREICH VON BENUTZUNG DER SIX SIGMA METHODE AM BEISPIEL DER POMMERN REGION

ZUSAMMENFASSUNG. Hintergrund: Six Sigma ist mit den Eigenschaften der Produkten wie auch Parameter der Aktionen, die um diese Produkte zu erhalten notwendig sind, verbunden. Auf der anderen Seite, ist es ein mehrstufiger, zyklischer Prozess, gerichtet auf die Verbesserungen. Es gibt ein wachsendes Interesse an Six Sigma Methodik bei den kleinen und mittleren Unternehmen (KMU), aber es gibt noch viel zu wenig Publikationen auf diesem Thema, besonders die auf gute empirische Ergebnisse basieren. Die Vorstudien haben schon gezeigt, dass nur ein kleiner Teil der Unternehmen aus diesem Sektor in Pommern Region verschiedene Elemente dieser Methode bemerkt und benutzt.
Methoden: Die Unternehmen wurden in Gruppen nach der Art ihrer Aktivitäten sowie die Beschäftigungsgröße geordnet. Die Fragebögen wurden zu 150 zufällig ausgewählten Organisationen in zwei Schritten geschickt. Die Fragen des Fragebogen waren über allgemeinen Informationen über ein Unternehmen, das Niveau des Wissens und der praktischen Anwendung der Six Sigma Methodik, Meinungen über Verbesserungen der Prozesse in den Unternehmen wie auch Meinungen über Schulungen in Six Sigma-Methodik.
Ergebnisse: Folgende Hypothesen wurden vorgeschlagen und statistisch verifiziert. Die Antworten:
- Der Mangel an ausreichender Kenntnisse von Six Sigma Methodik in KMU begrenzt die Möglichkeit von der effektiven Überwachung und Verbesserung ihrer Prozessen - akzeptiert.
- Die Verwendung von statistischen Werkzeugen von Six Sigma Methodik erfordert die breite Aktion, um dieses Wissen bei den nationalen KMU zu popularisieren - akzeptiert.
- das Niveau des Bewusstseins für die Bedeutung wie auch praktische Anwendung von Six Sigma-Methodik in produzierenden KMU ist höher als in KMU, die Dienstleistungen anbieten - abgelehnt, das Niveau ist dasselbe.
- Das Niveau des Wissens und der Nutzung von Six Sigma-Methodik in mittleren produzierenden Unternehmen ist deutlich höher als in kleinen produzierenden Unternehmen - akzeptiert.
- Das Niveau der Kenntnisse und der Anwendung von Elementen der Six Sigma Methodik in KMU ist positiv spürbar von diesen Unternehmen, die das Qualitätsmanagementsystem nutzen - akzeptiert.
- KMU verbessern lieber die existierenden Prozesse anstatt radikal umzubauen, um die Unbeständigkeit zu reduzieren - akzeptiert.

Fazit: Das Niveau der Kenntnisse von Werkzeuge und Techniken von Six Sigma Methodik in KMU in Pommern Region ist niedrig und verlangt eine breite Aktion um dieses Wissen zu popularisieren. Das Niveau des Bewusstseins für die Bedeutung wie auch die praktische Anwendung von Six Sigma Methodik in den produzierenden Unternehmen unterscheidet sich nicht wesentlich von desjenigen in Unternehmen die Dienstleistungen anbieten, aber ist höher in mittleren Unternehmen als in kleinen Unternehmen. Die Einführung des Qualitätsmanagementsystems hat auch einen positiven Einfluss auf diesem

Niveau. Die Unternehmen von diesem Sektor verbessern lieber die existierenden Prozesse anstatt radikal umzubauen, um die Unbeständigkeit zu reduzieren.

Codewörter: Six Sigma, Kleine und mittlere Unternehmen (KMU), Untersuchungen.

Prof. nadzw. dr hab. inż. Piotr Grudowski
Faculty of Management and Economics
Gdansk University of Technology
Dr inż. Piotr Waszczur
Faculty of Mechanical Engineering
Gdansk University of Technology
e-mail: pgrudows@pg.gda.pl, pwasz@mech.pg.gda.pl

LogForum

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 4

> Scientific Journal of Logistics <

http://www.logforum.net

THE MEANING OF LOGISTICS CAPABILITIES IN ACHIEVING THE MARKET SUCCESS BY A COMPANY

Rafał Matwiejczuk

Opole University, Opole, Poland

ABSTRACT. Background: The symptom of the market success by a company is to reach the expected market effects (e.g. market share, customer satisfaction, customer loyalty) as well as economic ones (e.g. profits, rentability, return on capital). As a result, the company may achieve a stable and long-term competitive advantage as well as strengthen its market position.
Methods: The abilities to use existing resources, which play an important role in achieving a market success, can be divided into operational and dynamic ones. The logistics abilities are one of the most important ones for a company. The comparison of these two kinds of logistics capabilities are presented, compared and evaluated.
Results: the role of logistics capabilities in achieving a market success by the company in light of the results of research carried out in the world, including Poland, was discussed, evaluated and confirmed.
Conclusions: The influence of logistics capabilities on the market success of a company was confirmed. The development of an effective strategy and organization solutions in the logistics seems to be the most important process associated with the use of potentials (capabilities as well as resources and competencies) and leading to achieving a market success of a company.

Key words: logistics, abilities, capabilities, market success.

INTRODUCTION

According to the principles of so-called Resource-Based View, the conditions for achieving a market success by the company are: having valuable and unique resources, which are additionally difficult to copy by competitions as well as having the abilities to use them in order to achieve targets. This allows the company to offer products and services, which not only correspond to the expectations of customers but also are more beneficial (better seen), in comparison to the competitors' offer. Resources and capabilities as well as competences developed on their basis, are the potential of a market success of a company. A.Sennheiser and M.Schnetzler [2008] discussed this problem and indicated the close relationship between the potentials of a success and so called factors of a success. According to them, the success factors are, on the one side, the competences, consisting of individual abilities, and on the other side, the resources of a company, which form together the basis for the potential of a market success. A.Sennheiser and M.Schnetzler [2008] stress that the previous identification of appropriate logistics capabilities is the condition of the development of logistics potential of a market success. The aim of this paper is the assessment of the role of logistics capabilities in achieving a market success by the company in light of the results of research carried out in the world, including Poland.

Citation: Matwiejczuk R., 2011, The importance of logistics skills in achieving the market succes by a company. LogForum 7, 4, 4
URL: http://www.logforum.net/vol7/issue4/no4
Accepted: 06.09.2011, on-line: 5.10.2011.

THE ESSENCE OF THE CAPABILITY

Overall, the capability of a company is a set of its individual abilities, which enable the fulfilment of its tasks [Prockl 2007]. The main feature (indicator) of the capabilities of a company is its orientation to achieve desired effects (i.e. planned and not random ones), which are obtained by purposeful and coordinated ways of the active involvement of resources. The sample definitions of capabilities are presented in the Table 1.

The capabilities of the company are oriented on an active and efficient use of resources in order to achieve the assumed targets. The active character of the engagement of the resources is reflected in the fact that they are assigned to individual tasks, where they are useful or even indispensable. However, the efficiency of the use of resources is manifested in the creation of an offer of products and services for the customers (creating the appropriate value for a customer) as well as in achieving the expected (planned) market and economic effects by a company. This can lead to achieving a competitive advantage and a market success by the company.

OPERATIONAL CAPABILITIES VS. DYNAMIC CAPABILITIES

The concept of Dynamic Capabilities is the development of the concept of resources approach. The operational capabilities and dynamic capabilities can be distinguished within this concept (Fig. 1).

Table 1. The definitions of capabilities
Tabela 1. Definicje zdolności

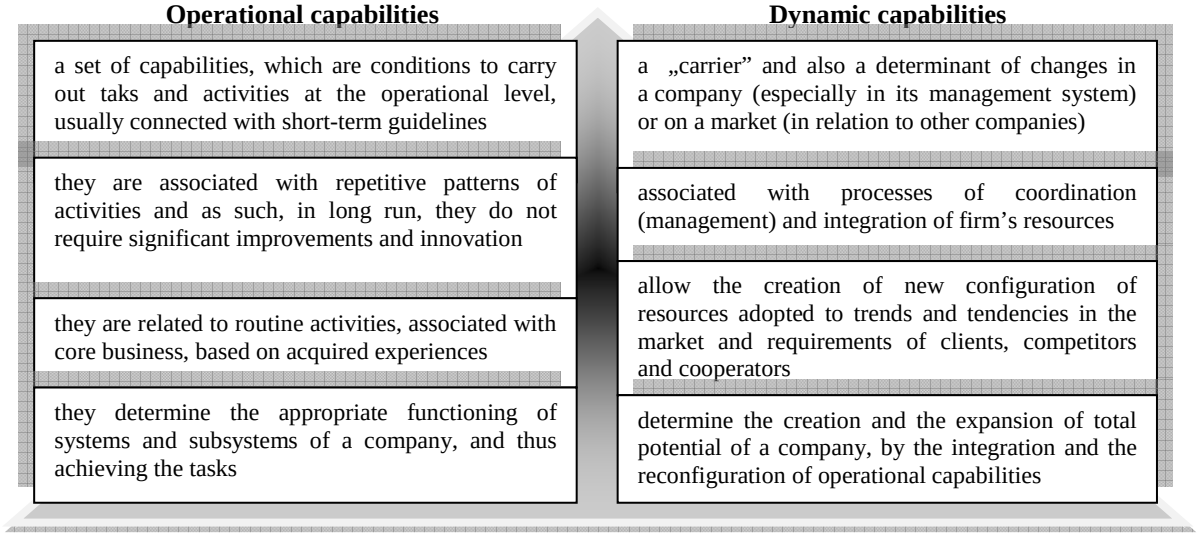
Authors	Definition of capabilities
C. Brush, P. Greene, M. Hart	Capabilities are abilities of a company, which allow utilizing its resources in order to achieve desired effects.
P. Daugherty, H. Chen, D. Mattioda, S. Grawe	Capabilities are the "sets" of abilities of a company to collect, integrate and use the resources. The resources can be defined as repetitive "patterns" of operations, associated in the use of the resources to create, produce and/or offer products on the market.
G. Day	Capabilities are a complex "set" of abilities and accumulated knowledge, which are the condition of the appropriate coordination of activities of a company and the use of its resources.
R. Grant	Capabilities are the abilities associated with a set of resources, which enable to execute specific tasks or activities.
U. Ljungquist	Capabilities are the processes (sets of activities) of mutual interaction of resources (tangible and intangible), which are characteristic (unique) for a company
S. Sharma, H. Vredenburg	Capabilities are the coordinating mechanisms, which enable the most efficient and competitive use of tangible and intangible resources of a company

Source: own work based on Brush, green, Hart 2001, Daugherty et al. 2009, Day 1994, Grant 1991, Ljungquist 2007, Sharma, Vredenburg 1998.

The operational capabilities of a company consist of all routine operations associated with the core business of a company [Teece, Pisano, Shuen]. The routine activities are performed based on experiences acquired in the previous activities of a company and as such are certain repetitive patterns of a conduct, often do not require the significant improvements. Nevertheless, the operational capabilities determine the survival and functioning of a company, and therefore they are indispensable

for the appropriate fulfilment of current activities and tasks. The operational capabilities can be defined as a set of abilities to use the existing resources to achieve current, often routine purposes.

On the other hand, the dynamic capabilities are related to the integration and the reconfiguration of the resources, as well as to their acquisition or disposition by a company. It enables actively to adapt to changes on the market or even to create them. The dynamic capabilities can be described as strategic activities and mechanisms, by which a company can create new configuration of resources (resource bases) under condition of the emergence of new markets, their diversification, development and decay [Eisenhard, Martin 2000]. At the same time, the dynamic capabilities determine the structure, the integration and the reconfiguration of operational capabilities, creating the conditions for achieving the market success by a company.



Source: own work based on: Teece, Pisano, Shuen 1997, Eisenhard, Martin 2000, Prockl 2007.

Fig. 1. Operational capabilities vs. dynamic capabilities
Rys. 1. Zdolności operacyjne vs. zdolności dynamiczne

OPERATIONAL AND DYNAMIC CAPABILITIES AND MARKET SUCCESS OF A COMPANY

The logistics capabilities result from the integration of logistics resources and individual logistics abilities. As mentioned above, the abilities consist of specific skills. The logistics skills are the developed procedures for the development of logistics "qualifications". These skills enable to collect, integrate and use the logistics resources to achieve the expected market and economic results. In this sense, the logistics skills determine the use of logistics resources (sets of resources) to achieve the agreed targets and tasks.

The logistics resources of a company can be involved in the fulfilment of such tasks like to offer logistics services in line with expectations of customers or to provide the required level of logistics service. To achieve these objectives, it is essential to develop the appropriate logistics capabilities, which enable to offer customers the right goods in right places, in right time, in appropriate quantity and quality, at right costs and together with right information. It can be noticed, that the logistics capabilities enable the identification of customers' preferences as well as the submission of a market offer, which provides the solution to their problems, by adapting the logistics services to customers expectations, securing the required service level, providing the goods under conditions, which are adequate from the standpoint of customers, etc.

Logistics capabilities can be developed both in the real sphere and in the adjustable sphere. The capacibilities assosiated with the real sphere can be connected with such processes as transport, warehousing, handling, packaging and labelling. The capabilities assosiated with the adjustable sphere concern the processes of the management of the flows of goods and information within a company and a supply chain.

The logistics capabilities can be also divided into operational and dynamic ones. The logistics operational capabilities include routine activities assosiated with current logistics tasks and related to short-term guidelines of the company, such as e.g. "the registration of an amount and a structure of incomes from logistics services, estimations of levels and structures of stocks or the estimation of the effectiveness of the utilization of warehouses. In this sense, the logistics operational capabilities allow to use the existing potentials of the market success of a company.

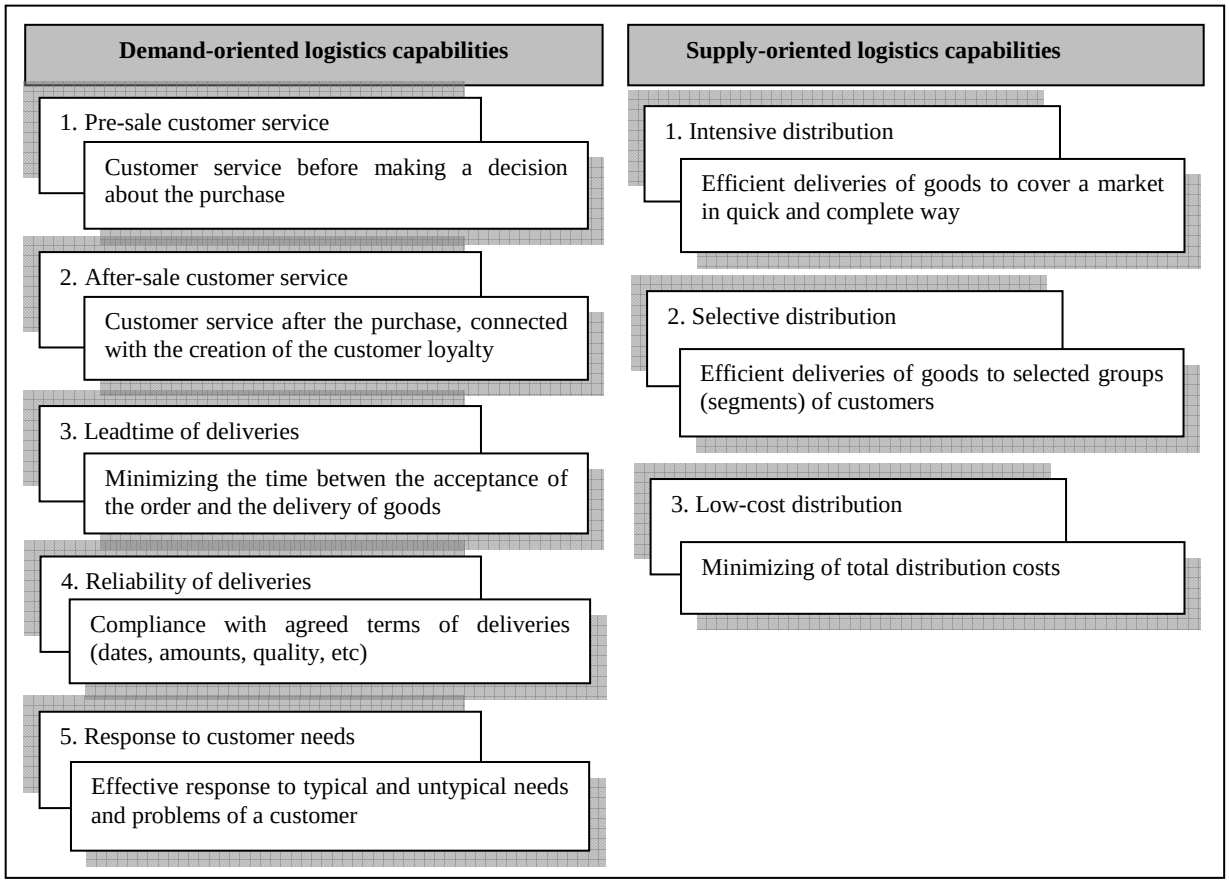
The logistics dynamic capabilities are oriented not exactly on the use of existing potentials of the market success of a company, but on their long-term development and growth. These capabilities are a kind of "carrier" of changes, occurring both in management systems of a company as well as in the market. The dynamic logistics capabilities allow more effective (in comparison to operational capabilities) use of logistics resources of a company by the "creation" of new, more innovative configuration, which allow better adjustment to market changes.

LOGISTICS CAPABILITIES AS DETERMINANTS OF MARKET SUCCESS OF A COMPANY ON THE BASE OF RESEARCHES CONDUCTED BY E.MORSH, C.DRÖGE AND S.VICKERY

The interesting researches related to the assessment of the possibilities of the utilization of logistics capabilities to achieve the competitive advantage and a market success by a company, were conducted by E. Morash, C. Dröge and S.Vickery [1996]. The researches were conducted using the method of the phone interview, based on the questionnaires sent previously by e-mail. 65 top managers took part in this survey, operating in the companies of the furniture industry, having over 10 Mo USD of revenues in a year. The scale from 1 (the least important) to 7 (the most important) was adopted to evaluate each logistics capability. Both the values and the changes of the values of indicators ROA, ROI and ROE were taken as the basic indicators of a success. The results of those researches suggest that the analysis of the logistics capabilities of a company can lead to distinguishing those capabilities, which have the strategic significance for the achievement of expected market and economic effects. The strategic logistics capabilities in the research of E. Morash, C. Dröge and S.Vickery were divided into two groups: demand-oriented capabilities (i.e. from the perspective of the preferences and expectations of customers) and supply-oriented capabilities (from the perspective of companies, which offer products and services on the market (Fig 2)).

The logistics capabilities, seen from the perspective of customers, allow to offer the expected level of logistics services, primarily by identifying the preferences and expectations of customers, providing the required speed and reliability of deliveries, and consequently, developing the solutions, which enable effective to react on the needs of customers (solving the customers' problems). The concentration of a company on the development of this group of logistics capabilities can lead not only to prepare more clear logistics offer for customers (who will want to learn it closer and therefore to make more conscious choice) and to build long-term relations with customers, based on mutual trust and loyalty.

The development of adequate logistics capabilities of a company, seen from the perspective of the supply, is the condition to secure the required level of the logistics service. These capabilities are related mainly to design and secure the proper functioning of the distribution systems according to market (customers') expectations and solutions used by competitors. It requires the choice of such distribution strategy, which lead not only to the fulfillment of customers' needs and expectations but also to the achievement of measurable benefits by a company.



Source: Morash, Dröge, Vickery, 1996.

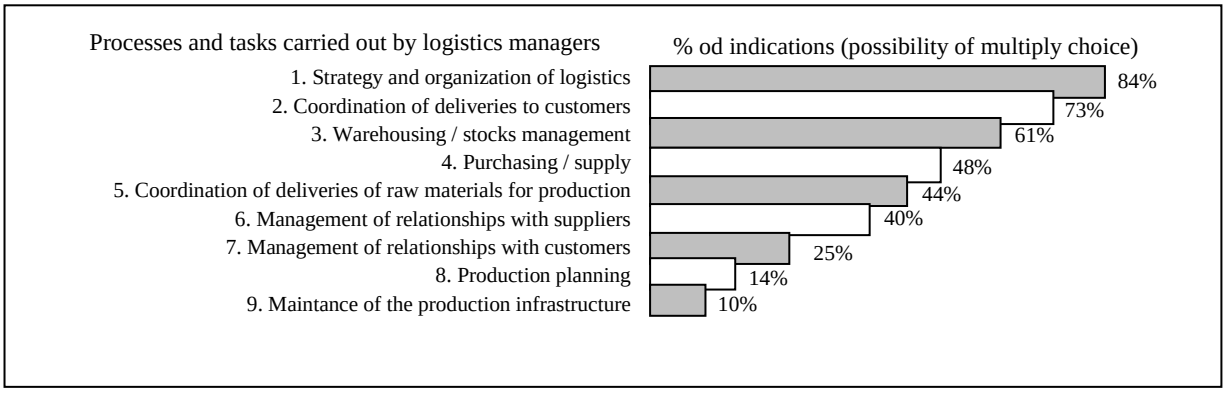
Fig. 2. Strategic logistics capabilities in researches of E.Morash, C.Dröge and S.Vickery
Rys. 2. Strategiczne zdolności logistyczne w badaniach E.Morash, C.Dröge and S.Vickery

The results of researches conducted by E. Morash, C. Dröge and S.Vickery indicate, that the strategic logistics capabilities can influence the market success of a company [Morash, Dröge,Vickery 2004]. This is especially true in case of demand-oriented capabilities. According to questioned managers, the most important ones among them are: reliability of the deliveries (average value 6,34), after-sale customer service (6,13), effective response to customers' needs (6,02), rate of deliveries (5,88) and pre-sale customer service (5,62). The supply-oriented capabilities are considered by questioned managers as the less important in achieving the success by a company. The average values were: intensive distribution 5,47, selective distribution 4,87 and low-cost distribution 4,61.

SUMMARY AND DIRECTIONS OF FUTHER RESEARCHES

The influence of logistics capabilities on the market success of a company was confirmed in many previously conducted researches [Defee, Frugate 2010]. Beside the evaluation of the direct relationships between logistics capabilities and a market success of a company, the recognition of these capabilities can be based on the evaluation of logistics processes and tasks, whose fulfilment affects changes in the management system of a company. The improvement of this system can lead to the achievement of the market success of a company. The attempt of the identification of the most important processes and tasks, for which the logistics managers are responsible, was taken in researches of the Department of Logistics and Marketing of Opole University (Fig. 3) as a grant "Logistics determinants of the management of a company". The research was conducted in years

2010-2011. 111 companies took part in this research. They represent five sectors: mining, processing industry, media industry, building industry and commerce.



Source: own work based on research of Department of Logistics and Marketing of Opole University.

Fig. 3. The most important processes and tasks carried out by logistics managers
Rys. 3. Najistotniejsze procesy i zadania realizowane przez menedżerów logistyki

According to surveyed companies, the logistics managers concentrate on the strategy and the organization of the logistics (84% of indications), the coordination of deliveries to customers (73%) as well as the warehousing and the effective stocks management (61%). The development of an effective strategy and organization solutions in the logistics seems to the most important process associated with the use of potentials (capabilities as well as resources and competencies) and leading to achieving a market success of a company. The directions of further researches can focus on the identification of logistics capabilities and their influence on the market success on the one side, and on the other side on the development of the logistics, understood as a result of the integration of resources and logistics capabilities of a company.

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ZNACZENIE ZDOLNOŚCI LOGISTYCZNYCH W OSIĄGANIU SUKCESU RYNKOWEGO PRZEZ PRZEDSIĘBIORSTWO

STRESZCZENIE. **Wstęp:** Przejawem sukcesu rynkowego przedsiębiorstwa jest zrealizowanie oczekiwanych efektów rynkowych (np. udział w rynku, zadowolenie klientów, lojalność klientów) i ekonomicznych (np. zysk, rentowność, zwrot z kapitału). W rezultacie, przedsiębiorstwo może zdobyć trwałą i długofalową przewagę konkurencyjną oraz wzmocnić swoją pozycję rynkową w porównaniu do konkurentów.
Metody: W osiąganiu sukcesu rynkowego ważną rolę pełnią zdolności wykorzystania posiadanych zasobów, które można podzielić na zdolności operacyjne i zdolności dynamiczne. Wśród zdolności przedsiębiorstwa istotne znaczenie posiadają zdolności logistyczne. Wykonano porównanie tych dwóch rodzajów zdolności wraz z ich oceną przydatności.
Wyniki: Rola zdolności logistycznych w osiąganiu sukcesu rynkowego przez przedsiębiorstwo w świetle badań przeprowadzonych zarówno na świecie, jak i w Polsce, została poddana dyskusji, oceniona i potwierdzona.
Wnioski: Wpływ zdolności logistycznych na osiągnięcie sukcesu rynkowego przez przedsiębiorstwo został potwierdzony. Rozwój efektywnej strategii i rozwiązań organizacyjnych w logistyce wydaje się być najważniejszym procesem związanym z wykorzystaniem potencjałów (zarówno zdolności jak i zasobów i kompetencji) prowadzących do osiągnięcia sukcesu rynkowego przez przedsiębiorstwo.

Słowa kluczowe: logistyka, zdolności, sukces rynkowy.

DIE BEDEUTUNG DER LOGISTISCHEN FÄHIGKEITEN IN DER ERREICHUNG DES MARKTERFOLGES DER UNTERNEHMEN

ZUSAMMENFASSUNG. Hintergrund: Die Erscheinung des Markterfolges des Unternehmens ist die Erreichung der erwarteten Markteffekten (z.B. Marktanteil, Kundenzufriedenheit, Kundenloyalität) und ökonomischen Effekten (z.B.

Gewinn, Rentabilität, Kapitalverzinsung). Als das Ergebnis, das Unternehmen kann dauerhafte und langfristige Wettbewerbsfähigkeit gewinnen, wie auch seine Marktposition verstärken.
Methoden: Die Fähigkeit, die vorhandenen Ressourcen zu nutzen, ist sehr wichtig für die Erreichung des Markerfolges. Diese Fähigkeiten können in die operativen und dynamischen Fähigkeiten eingeteilt werden. Und die logistischen Fähigkeiten sind sehr wichtig zwischen allen Fähigkeiten des Unternehmens. Der Vergleich dieser zwei Arten von logistischen Fähigkeiten wird vorgestellt, vergleichen und ausgewertet.
Ergebnisse: Die Rolle der logistischen Fähigkeiten in der Erreichung des Markterfolges der Unternehmen in den Ergebnisse der weltlichen und polnischen Untersuchungen, wurde diskutiert, bewertet und bestätigt.
Fazit: Der Einfluss der logistischen Fähigkeiten in der Erreichung des Markterfolges der Unternehmen wurde bestätigt. Die Entwicklung einer wirksamen Strategie und organisatorischen Lösungen in der Logistik scheint der wichtigste Prozess, mit der Ausnutzung der Potentialen (Fähigkeiten sowie Ressourcen und Kompetenzen) gebunden, zu sein und zur Erreichung eines Markerfolgs der Unternehmen zu führen.

Codewörter: Logistik, Fähigkeit, Marketerfolg.

Rafał Matwiejczuk
Opole University
Faculty of Economics
Department of Logistics and Marketing
45-058 Opole
ul. Ozimska 46a
e-mail: rmatwiejczuk@uni.opole.pl

This article was prepared as a part of a research project "Logistics determinants of the business management", conducted under the supervision of Prof. Dr. hab. Peter Blaik, at the Department of Logistics and Marketing at the University of Opole in years 2009-2011.

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 5

http://www.logforum.net

VIRTUAL LOGISTICS AS A SUPPORT FOR THE DECOMPOSITION PROCESS OF A SUPPLY CHAIN (CONCEPTUAL REFLECTIONS)

Danuta Kisperska-Moroń

University of Economics in Katowice, Poland

ABSTRACT. Background: Traditionally the concept of the "supply chain" is connected with various forms of the technical, organizational and economic integration. The integration deals mainly with multilateral relations among firms, thus constituting subsequent links of products flows in supply chains and creating complex networks of business connections. Due to social and economic factors, and mainly outsourcing and resulting accent on logistics services, traditional supply chains become decomposed. Therefore, there is a need to reconsider some concepts connected with this process.
Methods: The description and analysis of present and decomposing supply chains were presented and discussed. The analysis of reasons and possibilities to give up the processes of the absolute integration of supply chains in the direction of decomposed structures and the indication of possibilities to use the concept of a virtual logistics as a concept, which allows essentially such actions, was conducted.
Results: The disintegration of traditional value chains is one of these kinds' concepts, which are reflected also in classic supply chains. Probably the commonly used methods of the research and analysis of these supply chains do not conduce to make decisions under conditions of the lack of the continuity of business processes. Old methods and techniques of the management do not fit fully to modern business requirements, which are probably not even fully highlighted and properly understood.
Conclusions: The saturation of modern supply chains with services caused significant modifications of the logic and many mechanisms of their functioning, which in turn can lead to changes of a paradigm of the management of these more and more complex business structures. The aspirations of companies to achieve the competitive advantage on modern markets help to change the structure and the nature of supply chains, which operate on these markets, in the direction of their virtualization.

Key words: supply chain integration, decomposition of supply chains, virtual logistics.

INTRODUCTION

The “Supply chain” covers the set of features, which together create the specific value in processes of the management of the products flow. The most essential features of these chains are:

- they cover the whole process of delivering goods and services to final consumers,
- they include all participants (including those who run the logistic activities), starting from first deliver of the goods to the final user,
- the scope of activities covers the procurement, the production and the distribution,
- the management exceeds the boundaries of the organization and includes planning and supervision over the activities of other organizational units,

Citation: Kisperska-Moroń D., 2011, Virtual logistics as a support for decomposition process of supply chain (conceptual reflections). LogForum 7, 4, 5
URL: http://www.logforum.net/vol7/issue4/no5
Accepted: 11.09.2011, on-line: 5.10.2011.

- the common information system available for all participants of a chain enables to coordinate the activities of the organization,
- organizations, being the participants of a chain, achieve their own goals due to the functioning of the chain as a whole.

The existing concepts of the holistic look at the functioning supply chain do not always correspond to the real business processes, because at present the decomposition and the discontinuity of activities are the main characteristics of these processes. Under these conditions, the processes of the management of supply chains and logistics processes connected with them undergo the specific changes.

The aim of this paper is the analysis of reasons and possibilities to give up the processes of the absolute integration of supply chains in the direction of decomposed structures and the indication of possibilities to use the concept of a virtual logistics as a concept, which allows essentially such actions. The conducted contemplations present the basic assumptions of the integration processes within supply chains, indicate the main reasons of the decomposition of these chains and present the key elements of the concept of a virtual logistics, which are possible to be used in temporal supply chains.

INTEGRATION AS A PARADIGM OF FUNCTIONG OF SUPPLY CHIANS

The management of products' flow according to above defined concept of the "supply chain" means "...supervision of all subsequent steps connecting with the movement of products, irrespective of the legal, political or geographical boundaries, starting from the supplier of raw materials until to final deliveries to final consumers, deciding of a specific part of the demand..." [Cooper 1994]. This type of the integration often goes beyond typical logistic processes.

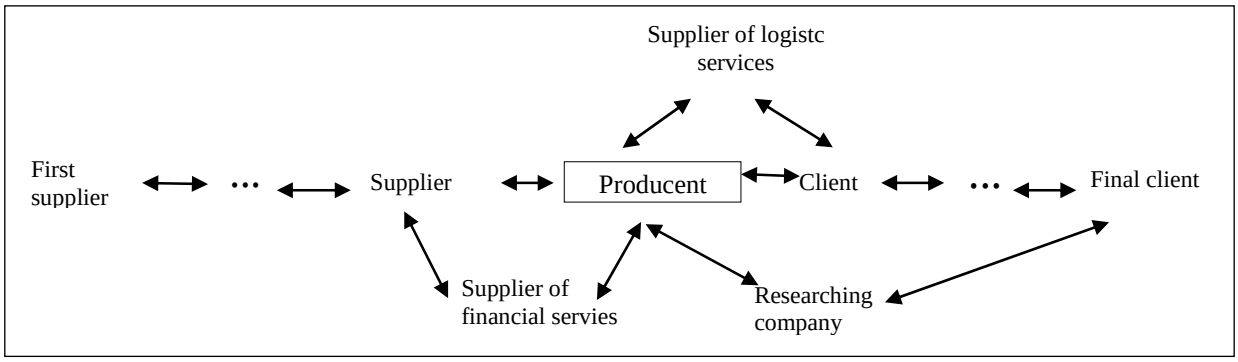
The classical definitions of the supply chain are presented in the table 1.

Table 1. Main definitions of the supply chain within the framework of the integration concept
Tabela 1. Najważniejsze definicje łańcucha dostaw w ramach koncepcji integracyjnej

Author	Definition of a supply chain
L.M.Ellram, M.C.Cooper	"The integrative philosophy for the purposes of the management of a total flow in distribution channel starting from delivers to final consumers"
F.Hewitt	"The integration in a supply chain is the result only of the modelling of business processes, and not of modifying of existing functional organizations"

Source: Ellram, Cooper, 1990, F.Hewitt 1994.

There are many definitions of a supply chains [Betchel, Jayaram 1997]. Although, the philosophy of the integration of a company with its suppliers and customers of products and services in order to achieve additional successes and market benefits is described the best by so-called "final supply chain" [Mentzer 2001], which is a group of all companies involved in mutual flows of products, services, finances and information, starting from an initial supplier to a final client (Fig 1). So-called main participants and specialized participants are the institutional elements of supply chains.



Source: Mentzer J.T. et al. 2001

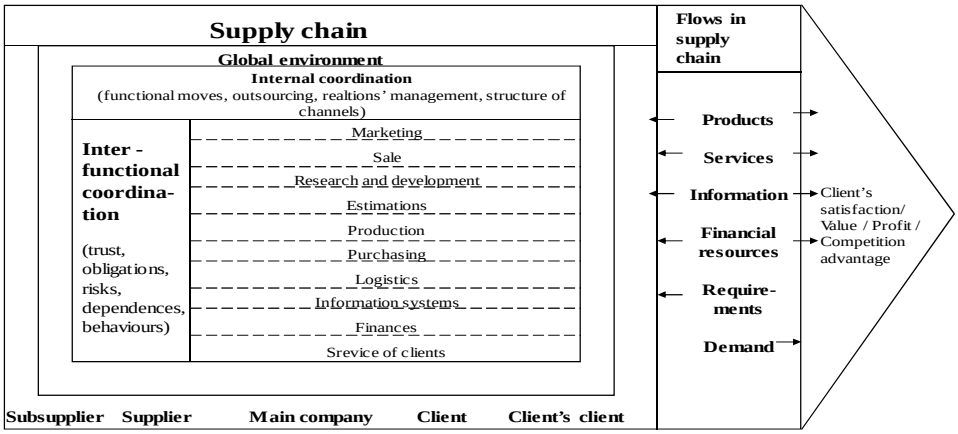
Fig. 1. Relations in the final supply chain
Rys. 1. Relacje w ostatecznym łańcuchu dostaw

The main participants are the main companies of the products' flow, fulfilling the role of suppliers and sub-suppliers and clients (intermediate: producers, traders, and final consumers). They are producers of manufacturing industry, mining, agriculture as well as wholesalers and retailers. The most diversified group in terms of forms is the group of wholesalers; they can represent the classical wholesale trade, fulfill the function of trade agents or sales agents of specific producers. The participants specialized in supply chains belong to two main groups: functional specialists and supporting specialists. Functional specialist companies provide to the main participants such services as transport, warehousing, completion, merchandising, etc. Supporting companies provide services in the areas of finances, information, advertising, insurance as well as research and consultation.

The interaction of participants within the supply chain consists not only on mutual relations with suppliers and customers in the process of goods' flow, which are called often as a partnership or alliances [Ellram, Cooper 1993]. The integration of the supply chain is based not only on cooperation between two companies, but also rather on the simultaneous relations of all its participants [Mentzer 2001]. So defined integration is the results of decisions made by individual persons or/and institutions [Kisperska-Moroń 1999].

The close integration with suppliers and customers in order to achieve additional benefits and market successes is the dominant philosophy in the concept of the "supply chain". The whole orientation of functioning of the supply chain is moved from problems of the inventory management in an individual company on the optimal inventories allocation from the perspective of the whole supply chain. The integration school in the literature is concentrated on the integration of separate areas of a chain into the system, defined as the set of processes [Hewitt 1994], which aims to create the greatest possible benefits for this system [Ellram, Cooper 2001] by multiplying the value.

The integrated management of logistic processes carries the constant flow of products through a stable chain of subsequent parts, each of which creating the new added value [Stevens 2001]. This new value means, that each participant of this flow increases the value of a product or a service for following participants, which receive this product or service. Resulting from such concept of a chain, which increases a value, the "integrated logistics" (integrated management of logistic processes) can be understood as "applying the same logic in the processes of planning, allocation and controlling of resources connected with distribution, production support and purchasing processes" [Johnson, Wood 1993].



Source: Ellram, Cooper, 2001

Fig. 2. Model of processes and activities creating the value in the supply chain
Rys. 2. Model procesów i działań tworzących wartość w łańcuchu dostaw

The integration school in the literature focuses the attention on the integration of areas of the supply chain into the system defined as a set of processes [Hewitt 1994], which aims to create the greatest possible benefits for this system [Ellram, Cooper 2001] by multiplying the value.

Each basic supply chain consists of parts executing the processes of the organization of the supply, logistic support of the production as well as the distribution of goods to clients [Hoekstra, Romme 1992]. As a results of above mentioned processes, the supply chain is a specific form of a value chain in the form of a set of specialized and consecutive main activities, such as deliveries, manufacture, distribution and supporting activities connected with marketing, research and development, finances, etc. It is presented in figure 2.

The number of stages of the value chain, involving companies participating in the supply chain, determines the level of the vertical integration of this chain. The number of participants can increase or decrease and accordingly the level of a vertical integration (as an added value) can increase or decrease. The integration of activities within the supply chain put on the participants and leaders of the management the obligations of monitoring the processes, which take place there, controlling the changes and supporting the main process of creating a new value for the members of this chain as well as its clients [Pfhol, 1998].

RATIONALES OF THE DECOMPOSTION OF TRADITIONAL SUPPLY CHAINS

Currently we are witnesses of the quality changes of consequences important for the whole economic reality. The intensity and the scale of these changes include such elements as:

- the increasing globalization and the expansion of supranational networks of the influences,
- the economic deregulation and the privatization and at the same time the increasing market competitiveness leading to big mergers of companies,
- the political liberalization and transformation of political systems,
- increasing offers of capital and financial markets,
- rapidly developing information technologies,

- new quality expectations of clients, faster process of development and dying out of products,
- the intensive development of the service sector, etc [Płoszajski 2000].

The essential feature of changes occurring in today's economic reality is the increase of management problems as the synergic effect of both the increased complexity and the increased inconstancy. It leads to a repetitive discontinuity of development processes, although the characteristics of new social and economic order are still not entirely clear. Under these conditions, rapid changes of priorities and methods of the management of logistics processes can be observed, which diverge increasingly from the common traditional practices. The uncertainty and the risk are more and more often observed in supply chains and there is no possibility to reach the comfort of the certainty of activities. It leads to searching for new techniques of solving problems in the management of logistics processes, configured in the supply chain.

The main reason of many failures to obtain the proper competitive advantage of a company within the supply chain seems to be the lack of understanding of changes in the philosophy how the modern business functions. The location of a company in a classic supply chain assumes its stable position in a rigid value chain of the one-way, linear and sequential nature. In this situation, the process of adding the value consists in an effective and efficient fulfilment of consecutive steps within the process of deliveries to clients, and the adding of the value is the process of creating the additional costs associated with the successive phases of flows of goods and services.

However, in the practice of functioning of a company, there are many multilateral connections among companies, which are the reason, that the cooperating companies are simultaneously the participants of many supply chains, which leads to "creating diverse interorganizational relations and increasing number of cells at different points of flows of goods" [Swierczek 2009]. Already in the past, when the configuration of supply chains was not so complex, it was noted that ".. the management of the supply chain is a concept of analyzing and management of the whole network from suppliers to final customers in order to obtain the results, best to the whole system" [Ellram, Cooper 1990]. Finally, one can talk about the networks of supply chains, which create the systems of dependencies within the network of "... many interdependent companies, representing both the areas of the supply as well as the distribution..." [Rutkowski 2004]. Therefore, the linearity of the relationships among companies is here enriched by multilateral dependencies at different stages of the flow of products.

The present saturation of contemporary networks by the services should be pointed out in particular, which is caused by strong tendencies to outsource many processes, in logistics – first of all the transport and the warehousing. Therefore, in presently functioning supply chains, one can observe the specific mix of activities connected with material flows and the coordination of services, which could be described as "intangible goods consumed at the moment of their manufacturing in the form of various benefits and satisfaction offered for sale" [Payne 1996] by companies. The services are a part of the offer of companies cooperating within the supply chain and resulting from generally accepted active customer service before, at the time and after the transaction [Ballou 1992]. They have usually the complementary character in relation to the material product, e.g. in case of the services of the maintenance, installation, trade, transport and finances.

Due to the saturation of the physical flows of products by material and immaterial service processes, the degree of the uniqueness of activities conducted in the supply chains increases. They are shaped based on such characteristic features of services as:

- immateriality, because most of services are not connected with the manufacturing of material goods,
- diversity (heterogeneity), since the services are very varied and inconsistent,
- inseparability (simultaneity), since the services are provided by provider and simultaneously consumed by the client,
- instability, in absence of the possibility of the storage of services.

The process management on mature markets, saturated by services, which support products, changes completely its character and requires specific tools to support the decision making process within distribution systems. Finally, it leads to the change of nature of the economy, from industrial to the service one, which is under the influence of the following factors:

- the changing nature of the operation of companies,
- the increase of the competition,
- changing organizational roles,
- changing external requirements,
- abilities of information technologies [Zairi 1994].

As a result of above mentioned occurrences, there is a clear pressure on the decomposition of traditional value chains and the perception of each part of traditional supply chain as a potentially high competitive node with specific perfect competencies to implement specific processes. Such node (company) can become an element of different supply chains and different value streams depending on appearing the opportunities to begin or continue a business.

The virtualization of supply chains and networks becomes more and more common, although it is not properly established in the theory as well as in the practice. For above a decade, the virtual system of deliveries becomes a symbol of modern economic and social development, but still it is one of the most misunderstood and discussed concepts of the contemporary world. However, certainly, this concept has a significant influence on the change of the model of the competition of companies, which want to work in such temporary organizations and profit from opportunistic opportunities of the development [Kisperska-Moroń 2010].

VIRTUAL LOGISTICS AS A SUPPORT OF THE DECOMPOSITION OF SUPPLY CHAINS

The above presented concept of the decomposition of supply chains requires the creation of foundations for the functioning of so-called virtual logistics, which should allow implementing the scale benefits by the use of common resources and at the same time to preserve to maintain the profits from fulfilment of individual tasks and transactions by individual companies [Kisperska-Moroń 2009]. The increase of the utilization of resources is possible as a result of flexible, in comparison to demands, allocation of resources, while the shortening of delivery's time is possible through better management of operational priorities [Clarke 1998].

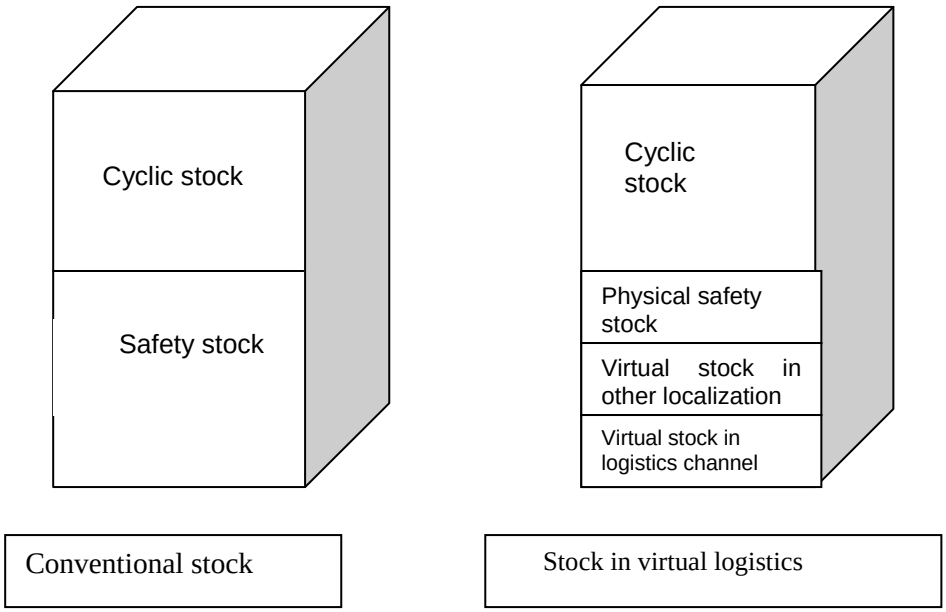
The localisation of resources or their form should not be important in terms of logistic support of scattered business processes, but it is important, that the adequate resources should be available according to requirements. The location of these resources, and most of all, stocks of products and transport services, can be of secondary importance in this case. Similarly, it should be irrelevant, whether the resources should be produced, delivered or purchased from external sources. The availability of these resources in accordance with the demand is the most important issue. Therefore, the important problem arises: how to ensure this availability in a way at a distance but for the specific production or distribution tasks located in specific space and time.

It should be assumed, that the virtual logistics could treat the product and transport logistics resources as goods, similarly to the role of the currency in banks' operations. It means that the logistics resources can be borrowed and sold, consolidated in a flexible way, divided or allocated. It is a very bold assumption, changing the exitisting system concepts of the logistics in terms of the construction of these systems as well as their effectiveness. Such concept of a virtual logistics requires a very wide range of the outsourcing and subcontracting of logistics services [Hoek 1998].

The logistics resources in the virtual logistics may include production processes, production sub-processes, logistics tools, vehicles, free transport capacities, material handling equipment, inventories,

spare parts or even warehousing spaces. The virtual logistics bases on the "trade" of these resources on a large scale. These resources are purchased and used in a remote way, and then lent or sold in the situation, when they become a surplus to current needs. The logistics services of various types may be traded individually or in the form of a portfolio of services, matched according to current market requirements for logistics services. The physical location of individual resources cannot be a significant obstacle in this process, the cost of their availability will be the only barrier of the method of the remote use of these resources. In practice, there is already a virtual system of making these resources accessible, based on Internet technologies, e.g. sales of free transport capacities in the international transport. It should be recognised, that the scope of this system is still very limited [Clarke 1998].

In practice, the fundamental logistics resource is the stock of goods in form of materials, finished products or goods. Departing from the classic form of the stocks, according to the concept of the virtual logistics, the stocks are created on the basis of properly planned production processes rather than the accumulation of physical goods. For this purpose, the products' flows will be adequately secured by the precise definition of logistics channels, by which the goods can be offered and by providing the necessary production capacities and resources in these logistics channels. According to such concept, the need to maintain the traditional safety stocks in a form of fix quantities of products in the warehouse are reduced (Fig 3).



Source: Clarke 1998

Fig. 3. Comparison of stocks' structure in traditional and virtual concept of a logistics
Rys.3. Porównanie struktury zapasów w tradycyjnej i wirtualnej koncepcji logistyki

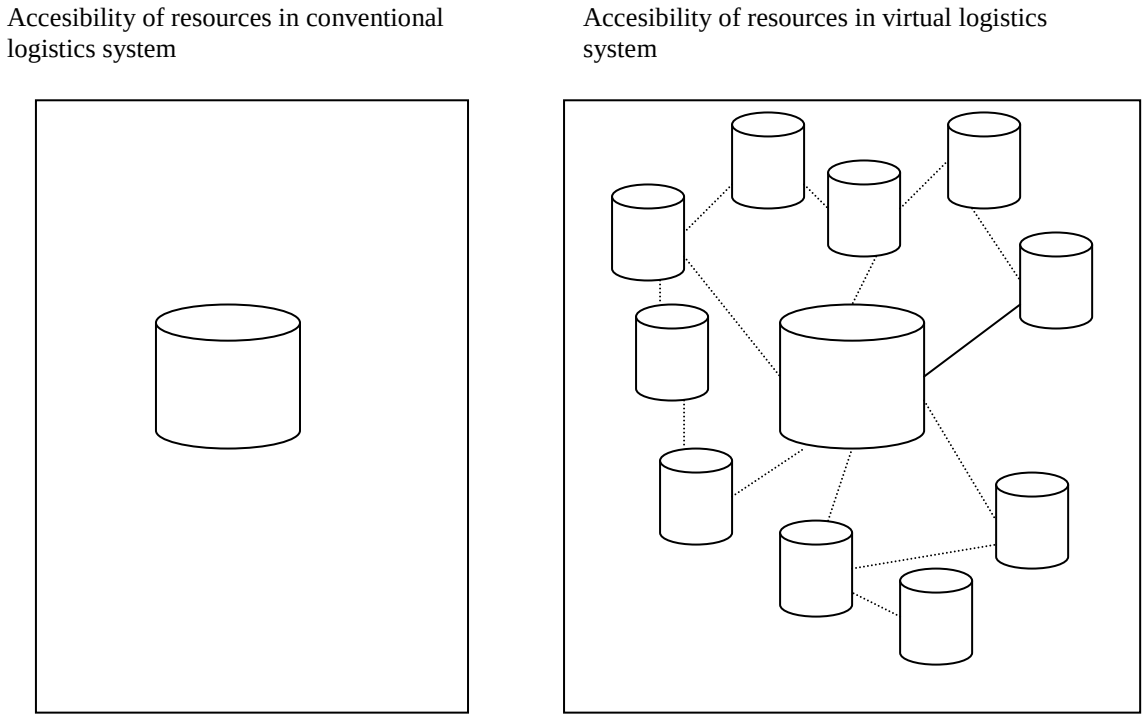
Additionally to stocks in traditional logistics channels, there are so called "virtual stocks", which appear in the virtual logistics, located in a place other than a location of a company. These are the physical stocks of goods, which can be obtained regardless of their location, by purchase and sale transactions, as well as by "borrowing" of these products without changing their localization [Kisperska-Moroń 2009]. The potential clients and their suppliers, in order to carry out local deliveries, can sell each other the products stored in remote warehouses without changing the physical localization of goods. In case of deliveries connected with covering long distances or bearing high transport costs, it is possible to look for alternative sources to fulfill the deliveries. The main criterion

for the selection of the source of a supply is the localization closer to the target point or lower costs of the transaction.

Similar to "virtual stocks", the direct supplies from producers can be used to eliminate the physical medium of a warehouse of a third party participant in the process of a goods' flow. In this way, the virtual logistics, based on huge information and Internet systems, can carry out the substitution of a transport through series of transactions, which leads to fast deliveries of physical goods to final customer. In this way, it is possible to eliminate high transport costs, to increase the profitability of supply and distribution processes, to improve the level of the customer service as well as to shorten the lead-times of deliveries.

As a conclusion, it can be stated, that the systems of the potential virtual logistics will be better organized and will function in a way different from a way, in which conventional logistics systems work.

The conventional logistics services require usually the allocation of large amounts of resources as a security buffer in case of significant fluctuations of supplies and changes of requirements for needed services. The concept of logistics resources in conventional and virtual systems is presented in the figure 4. The only easily available resources in the conventional logistics are these, located in one location. The virtual logistics has an easily access to logistics resources in external localization, as well.



Source: Clarke 1998

Fig. 4. The concept of the accessibility of logistics resources
Rys.4. Koncepcja dostępności zasobów logistycznych

There is a necessarity to use computerized information networks to locate and access indispensable logistics resources. Certainly, one of their characteristics is to base their work on systems of e-commerce and e-business [Croom 2005].

The exploiting of full potential of the virtual logistics needs not only to base them on public systems, allowing the access to information about logistics resources, but also far reaching standardization of logistics resources such as transport modes, sizes of vehicles, production processes, machines and products as well as handling operations. This type of the standardization allows

obtaining the high level of the compatibility and the consistency of various groups of users. The production systems should be modular. Additionally, there is a need to introduce monitoring systems, which will control the quality and ensure the accuracy, the reliability and the availability of logistics resources. The computer systems, which control the logistics, should be widely available, and logistics operations and processes must be synchronized in time. Similarly, the systems ensuring the efficient payment processes for providers of logistics services must be introduced. The regulations of the responsibilities of users of logistics services must also be introduced. Such virtual logistics systems can support the cooperation between the traditional supply chains and the decomposed ones in the area of enlarged regional and global markets.

There are a few basic rules to design virtual logistics systems:

- logistics resources are commodities, which have their functional availability,
- the separation of the ownership and the control over logistics resources from their physical localization allows the remote use of these resources,
- the change of the ownership of logistics resources or the modification of their use does not mean their physical transfer,
- there is a need of a public common access to information about logistics resources as well as the electronic trade of these resources,
- there is an integration of warehousing, transport and production services, in order to obtain the possibility to model the availability of products and the inventories' control [Power 2005].

The concept of the virtual logistics can provide an important support for the efficiency and the effectiveness of not only decomposed supply chains but also of more classic forms. It allows the movement of small volumes of products of a high value. It can be also implemented in small and medium-sized enterprises, which inherently carry out the flows of products under conditions less favorable than large companies do, because they are not able to achieve the same profits of the scale rate. The virtual logistics should facilitate them the consolidation of complementary products. In the long run, the virtual logistics should allow increasing the rationality of many logistic operations within supply chains, shortening the lead times as well as increasing the reaction capacity to changing demands. The higher level of the efficiency of the logistics will be demonstrated also in terms of external costs, resulting from savings of the energy and other resources, the reduced transport congestion and the reduction of the environmental pollution.

There are many conditions for the development of the virtual logistics, among them the necessity of the transformation of the TSL sector in the direction of higher use of information techniques as well as an enlargement of the range of logistics services, is one of the most important ones. The managers of this sector will have to face a greater diversity of transported goods and a bigger market offer of products and services.

SUMMARY

The economic difficulties, faced by companies in recent times, lead to a deep reflection on well-established ways of perceiving business processes and commonly accepted concepts of the management of logistics processes.

The disintegration of traditional value chains is one of these kinds' concepts, which are reflected also in classic supply chains. Probably the commonly used methods of the research and analysis of these supply chains do not conduce to make decisions under conditions of the lack of the continuity of business processes. Old methods and techniques of the management do not fit fully to modern business requirements, which are probably not even fully highlighted and properly understood.

It seems that we are standing right now before important transformations of the business and the business management. The saturation of modern supply chains with services caused significant

modifications of the logic and many mechanisms of their functioning, which in turn can lead to changes of a paradigm of the management of these more and more complex business structures. It can be also stated, that the aspirations of companies to achieve the competitive advantage on modern markets help to change the structure and the nature of supply chains, which operate on these markets, in the direction of their virtualization.

The understanding of this fact is the basis of the revolution of management systems in the area of the logistics. It seems that the consideration of modern concept of the virtual logistics can be a beginning of a new concept and methods of the business, the management as well as the achievement of objectives, put in ahead of them.

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LOGISTYKA WIRTUALNA JAKO WSPARCIE PROCESÓW DEKOMPOZYCJI ŁAŃCUCHA DOSTAW (ROZWAŻANIA KONCEPCYJNE)

STRESZCZENIE. **Wstęp**: W tradycyjnym rozumieniu koncepcja łańcucha dostaw obejmuje różne formy technicznej, organizacyjnej i ekonomicznej integracji. Pod pojęciem integracji należy rozumieć przede wszystkim różnokierunkowe połączenia między firmami, które to generują przepływy towarów w obrębie łańcuchów dostaw i przyczyniają się do powstawania złożonych sieci połączeń biznesowych. Z powodu różnych czynników socjalnych i ekonomicznych, a przede wszystkim rosnącej roli outsourcingu w usługach logistycznych, tradycyjne łańcuchy dostaw ulegają dekompozycji. Z tego też powodu wynika potrzeba przeanalizowania na nowo koncepcji związanych z tym procesem.
Metody: Przedstawiono i przedyskutowano opis i analizę łańcucha dostaw w aktualnej formie oraz po dekompozycji. Przeprowadzono analizę przyczyn i możliwości zaniechania procesów zmierzających do pełnej integracji łańcuchów dostaw na rzecz struktur zdekomponowanych. Wskazano możliwości stosowania logistyki wirtualnej jako koncepcji umożliwiającej takie procesy.
Wyniki: Rozkład tradycyjnych łańcuchów wartości jest jedną z koncepcji, która ma swoje odzwierciedlenie również w klasycznych łańcuchach dostaw. Prawdopodobnie tradycyjnie stosowane metody oceny i analizy tych łańcuchów dostaw nie będą odpowiednie do podejmowania decyzji w warunkach braku kontynuacji procesów biznesowych. Dawniej stosowane metody i techniki zarządzania nie sprawdzają się w pełni w obecnych warunkach, które nie są jeszcze nawet całkowicie przeanalizowane i zrozumiałe.
Wnioski: Nasycenie usługami współczesnych łańcuchów dostaw powoduje istotne modyfikacje w logice i mechanizmach ich funkcjonowania, co z kolei prowadzi do zmian paradygmatu zarządzania tymi coraz bardziej złożonymi strukturami biznesowymi. Dążenia przedsiębiorstw do osiągnięcia przewagi konkurencyjnej na współczesnych rynkach pomagają w zmianach struktury i natury łańcuchów dostaw w kierunku ich wirtualizacji.

Słowa kluczowe: integracja łańcuchów dostaw, dekompozycja łańcuchów dostaw, logistyka wirtualna.

DIE VIRTUELLE LOGISTIK ALS DIE UNTERSTÜTZUNG FÜR DEN ZERSETZUNGSPROZESS DER LIEFERKETTE (KONZEPTIONELLE ÜBERLEGUNGEN)

ZUSAMMENFASSUNG. Hintergrund: Das Konzept der Lieferkette ist traditionell mit verschiedenen Formen der technischen, organisatorischen und wirtschaftlichen Integration verbunden. Die Integration beschäftigt sich hauptsächlich mit multilateralen Beziehungen zwischen Unternehmen und nachfolgend verursacht die Produktenflusse innerhalb der Lieferketten wie auch die Erstellung der komplexen Netzwerke von Geschäftsbeziehungen. Aufgrund der sozialen und wirtschaftlichen Faktoren, von allem Outsourcing, werden die traditionelle Lieferkette zerlegt. Deshalb ist es notwendig, einige Begriffe, mit diesem Prozess verbunden, zu überdenken.
Methoden: Die Beschreibung und die Analyse der gegenwärtigen und zersetzen Lieferketten wurden vorgestellt und diskutiert. Die Analyse der Gründe und Möglichkeiten um die Prozesse der absolute Integration der Lieferketten aufzugeben, wurde durchgeführt. Die Richtung der zerlegten Lieferketten wie auch das Konzept der virtuellen Logistik wurden diskutiert.
Ergebnisse: Der Zerfall der traditionellen Wertketten ist eines, von dieser Art, Konzept die auch in klassischen Lieferketten gibt. Wahrscheinlich die üblichen Methoden der Forschung und der Analyse von diesen Lieferketten nicht genug sind um die Entscheidungen unter Bedingungen des Mangel an der Kontinuität von Geschäftsprozessen zu machen. Traditionellen Methode und Techniken der Verwaltung erfüllen nicht die modernen Geschäftsanforderungen, die wahrscheinlich noch nicht vollständig markiert und verstanden sind.
Fazit: Die Sättigung der modernen Lieferketten mit Dienstleistungen verursacht die erhebliche Änderungen der Logik und Mechanismen von das Funktionieren dieser Lieferketten. Und das bringt die Veränderungen des Paradigmas von der Verwaltung von dieser mehr und mehr komplexe Unternehmensstrukturen. Die Bestrebungen der Unternehmen, die Wettbewerbsvorteile auf modernen Märkten zu erreichen, helfen die Struktur von Lieferketten in die Richtung ihrer Virtualisierung zu verändern..

Codewörter: Integration von Lieferketten, Zersetzung der Lieferketten, virtuelle Logistik.

Danuta Kisperska-Moroń
Uniwersytet Ekonomiczny w Katowicach
ul. Bogucicka 14, 40-226 Katowice
Poland
e-mail: danuta.kisperska-moron@ue.katowice.pl

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 6

http://www.logforum.net

PROBLEMS OF LOGISTIC SYSTEMS SUSTAINABLE DEVELOPMENT IN DELIVERY CHAINS

Sergey Uvarov

St. Petersburg State University of Economics and Finance, St. Petersburg, Russia

ABSTRACT. Background: Realization of supply chains management paradigm, covering significantly more volumes of logistic space, logically leads to complication of logistic systems, which, in its turn, arises significant number of problems of both theoretical and practical character. In our opinion, not all the aspects of logistic systems design and their sustainable functioning have received by the present time corresponding coverage in scientific literature. More detailed consideration requires specific problems of logistic systems interaction with their environment. We can talk about formation of new scientific direction (which we suggest to name logistic environics), being applied addition to classical approach to design of logistic systems.
Methods: the formalized description of interaction process for logistic systems with the environment was presented and discussed from ecological, social, economical, organizational and technological, technical, natural scientific positions.
Results and conclusions: there is an interaction between logistics systems and the environment, but formalized description of logistic systems interaction process with the environment requires performance of complex interdisciplinary research from many different positions.

Key words: supply chains, logistic systems, logistic environment, logistic approach.

The aim of this article is to propose the scientific and methodological recommendations on management methods of supply chains, which consider the specificities of supply chains influence on the environment as well as mutial interactions between logistics systems and the environment.

Realization of supply chains management paradigm, covering significantly more volumes of logistic space, logically leads to complication of logistic systems, which, in its turn, arises significant number of problems of both theoretical and practical character. Addressing to theoretical analysis allows to specify typology of logistic systems in supply chains, reveal their specific qualities in new conditions and state adequate requirements to the problem of logistic systems design [Logistics ... 2009]. Addressing the question of reliability provision for logistic systems, that allows to increase reliability of supply chains at the expense of system management factor [Uvarov 2010], and also considering of ecological, organizational and technological sides of the reverse flows formation process in logistics systems [Logistics ... 2010] allowed to make a conclusion on the higher-order problem.

In our opinion, not all the aspects of logistic systems design and their sustainable functioning have received by the present time corresponding coverage in scientific literature. So, more detailed consideration requires specific problems of logistic systems interaction with their environment. In our opinion we can talk about formation of new scientific direction (which we suggest to name logistic environics), being applied addition to classical approach [Bauersocks 2005] to design of logistic

Citation: Uvarov S., 2011, Problems of logistic systems sustainable development in delivery chains. LogForum 7, 4, 6
URL: http://www.logforum.net/vol7/issue4/no6
Accepted: 11.09.2011, on-line: 5.10.2011.

systems. Revelation of these regularities undoubtedly will contribute to adequate answer for the requirements of modern economics globalization and will add existing base of logistic systems design.

Logistic system, as any material system, exists in concrete environment, which consists of everything, that is outside the considered system. Environment includes external in relation to it objects, which participate in forming of its integrative qualities mediately, through independent components of their systems and systems in whole [Lee et al. 2011] .

Logistic system, as any open system, constantly exchanges substance, energy, information - all necessary for provision of its vital activity, growth, development and improvement, with the environment. Material system cannot exist outside environment, cannot stay indifferent to the influence from the side of environment. If environment is favorable, system can successfully develop, under the influence of negative factors of environment system can collapse [Hajdul 2010].

Environment can be determined as objective material world, existing outside this system in all diversity of its demonstration, directly and mediately influencing each other.

Environment of logistic systems we shall call macro-logistic environment. Along with environment exists also internal environment of the system, which consists of higher levels of sub-systems and elements of system and interaction process between them, and also interaction with the environment. Logistic system internal environment we shall call micro-logistic environment. Exists dialectic relation (unity and struggle) of external and internal environments. Environment creates systems, and every system forms its internal environment, that can only develop in unity with external environment.

Interaction determines basic content of any environment, aims for performance of concrete work, action. Environment content is conditioned by the type of system elements mutual interaction and system with the environment. Interaction types depend on purpose, to which the system aims. Such purposes in logistic system may be creation of clear organization structure and actually organization of management process for material and accompanying it flows; achievement of supply high quality; performance of effective logistic functions and operations; rational management for all above motioned interacting processes [Melo, Nickel, Gama 2009].

In correspondence with set aims in interaction process of internal functional sub-systems of logistic systems and logistic systems between each other, are formed corresponding environments (table 1).

Significance of any material system consists not in the very fact of its existence as a material object, but in its interaction with the environment.

Appearance, development, improvement of systems, their collapse - all these is related with the character of their relations with other systems, environment. Interaction determines existence, structural organization and qualities of any material system. Interactions inside logistic systems, and also of the systems with the environment are complicated, multivariant and bear strictly purposeful character [Ghadge, Dani, Kalawsky, 2010].

Multitude of logistic systems, and also micro and macro-logistic environments exists only in constant interaction between each other. The more complicated is logistic system or environment, the more diverse and differentiated are their interconnections and properties. On the character of these interconnections depend degree, organization level of logistic system, its quality, reliability, sustainability, ability for development.

Table 1. Logistic environment and its sub-systems

Tabela 1. Środowisko logistyczne wraz z jego podsystemami

Logistic environment	**Content**	**Aims**
1. Micro logistic environment	Different types of interactions between managers and specialists, working in sub-divisions of logistic system, aimed at creation of its rational organization	Development and improvement of logistic systems; organization of basic and auxiliary logistic processes; effective usage of transportation and warehousing capacities; reduction of duration of order execution cycle; logistic coordination of interrelation with suppliers, consumers and logistic agents; rational decision of ecological problems.
1.1. Economical component of micro-logistic environment	Totality of economical relations, determining possibilities of logistic system	Performance of processes of production supply and support, distribution, and also effective functioning of the company in whole in the market.
1.2. Technological component of micro-logistic environment	Interaction between materials, incomplete production and finished product, between machinery and mechanisms of different stages of logistic process.	Improvement of machinery work and improvement of quality of logistical services for consumers.
2. Macro logistic environment	Economical, political, social and cultural environments, in conditions of which functions concrete logistic system	Optimization of conditions of goods movement process organization.
2.1. Economical component of macro logistic environment	Interactions (transactions) between logistic systems in the process of industrial and economic activity of companies and enterprises, distribution, exchange and consumption of finished product.	Creation of logistic potential of national economics, increase of possibilities for effective international economical relations in conditions of world economics globalization.
2.2. Technological component of macro-logistic environment	Interactions, connected with the development of technics and technology, with saturation of society with technical systems, growth of machinery, mechanisms and other technique influence on environment.	Development of innovation technologies, creation of more productive machines, mechanisms, equipment, transportation means, and also technical systems designated for provision of country economical security.

For every system are typical its own types of substance, energy and information, their determined volumes, which can be called affecting factor, transforming the system. Exactly affecting factor, possessing necessary and sufficient amount of substance, energy and information, is able to move, transfer, support development and improvement of the system. Imagine logistic system as result of interaction of micro- and macro-logistic environments factors. Logistic systems are impacted with the following factors:

x_i - factors of macro-logistic environment, positively influencing on logistic system;

$x`_i$ - factors of macro-logistic environment, negatively influencing on logistic;

y_i - factors of micro-logistic environment, that allow logistic system to influence on environment;

$y`_i$ - factors of micro-logistic environment, that do not allow logistic system to influence on environment;

z_i - energy, which is spent by logistic system for counteraction to external factors;

$z`_i$ - factors, collapsing logistic system from inside.

In this case, condition of sustainable development of logistic system will be the following:

$$\Sigma (x`_i + y`_i + z_i + z`_i) \langle \Sigma (x_i + y_i)$$

Logistic system is able for sustainable development in the case, if the sum of positively influencing factors of micrologistic and macrologistic environments exceeds the sum of negatively influencing

factors of micrologistic and macrologistic environments, factors, collapsing logistic system from the inside and expenses of energy, which it is necessary to spend by logistic system for counteraction to external factors.

Thus, logistic aims to regulation of the whole process of production manufacturing and services rendering from resources supplier to the final product consumer. It shall be noticed, that market economics in whole and sphere of distribution and circulation in particular are extremely sensitive to alien structures, artificially introduced to economical system. Logistics consistently fit into modern market economics, i.e. it is in demand by the whole way of economics development.

Macroeconomical aspect of logistics is in increase of public production effectiveness at the expense of reduction of expenses in the sphere of circulation, first of all of material and technical provision and transportation, with which is connected up to 98% of time and up to 40% of resources, appearing in the process of reproduction. Practically the search of ways for reduction of expenses is performed in the following directions:

- Improvement of management for the sphere of production provision, storage and distribution;
- Optimization of economic relations by improvement of marketing activity and interaction of suppliers, consumers and brokerage structures;
- Positive changes of material flows movement technology.
- Logistics suggests to consider the circulation system in all its complexity and diversity. Research of the development and functioning of large systems requires system approach. Other approach is impossible here. We can say, that logistic approach - is the system approach to research of social and economical and man-machine systems. Application of logistic approach to design of economical systems development supposes the solution of the following tasks:
- Set of aims for development and determination of their optimal combination;
- Determination of ways and means for achievement of these goals through revelation of connections and research of interaction of considered factors and concerned objects in quantitative form;
- Associativity of goals and means of their achievement with demand in resources, considering their limitedness.

From the point of view of integrated logistics, logistic approach is a multicriteria optimization of the business-process: so, designers shall take into account the requirements of manufacturability, transportability, ability for utilization at the stage of new products elaboration, and elaboration of package shall be performed with consideration of peculiarities of cargo treatment in different transportation types. Main instruments of logistic approach are analysis and synthesis of the researched system. System analysis allows to disclose the most significant factors, gives their characteristics, quantitative estimation of interaction with each other, determines their influence of researched system parameters. Synthesis is provided in the process of elaboration and functioning of formalized model of researched system parameters; this model unites factors in development dynamics of considered system [Hofer, Knemeyer 2009].

On micro-level logistic approach introduces changes into many conceptions of company's economics and organization of production process:

- Task of full use of capacities is replaced with the task of minimization of terms of circulation means pass through the enterprise;
- Initially may be foreseen reserve capacities for rapid reaction on the change in the market demand (it is understood, that doesn't mean availability of idle capacities. Under reserve is understood possibility of cooperation, purchase of services on products manufacturing or performance of certain production operations);
- One-sided orientation on reduction of expenses as a method of competition is replaced with the aim for the higher level of logistic service;

- Replacement of material resources of information on possibility of their operation acquisition on acceptable conditions (traditional supply agent turns into information broker);
- Absence of technological limitations for decrease of batch size for manufactured production and its determination from the conditions of delivery volume to consumers.

SUMMARY

It can be concluded, that there is an interaction between logistics systems and the environment, but formalized description of logistic systems interaction process with the environment requires performance of complex interdisciplinary research from ecological, social, economical, organizational and technological, technical, natural-scientific positions.

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PROBLEMY ZRÓWNOWAŻONEGO ROZWOJU SYSTEMÓW LOGISTYCZNYCH W ŁAŃCUCHACH DOSTAW

STRESZCZENIE. **Wstęp**: Realizacja paradygmatu zarządzania łańcuchem dostaw, która to obejmuje znaczny obszar logistyki, prowadzi do większej złożoności systemów logistycznych. To z kolei stwarza wiele istotnych problemów natury zarówno teoretycznej jak i praktycznej. Nie wszystkie zagadnienia związane z projektowaniem i funkcjonowaniem systemów logistycznych znajdują odpowiednie odzwierciedlenie w literaturze naukowej. Szczególnej uwagi wymagają powiązania i zależności systemów logistycznych z otaczającym je środowiskiem. Można tu mówić o nowym kierunku nauki (logistic environics) jako dodatku do klasycznego podejścia do projektowania systemów logistycznych.
Metody: Przedstawiono sformalizowany opis współzależności między systemami logistycznymi a środowiskiem, który następnie został przedyskutowany przy uwzględnieniu aspektów ekologicznych, socjalnych, ekonomicznych, organizacyjnych i technicznych.
Wyniki i wnioski: Istnieje zależność między systemami logistycznymi a środowiskiem, lecz sformalizowany opis tych zależności wymaga kompleksowych międzydyscyplinarnych badań, uwzględniających różne podejścia do tych zagadnień.

Słowa kluczowe: łańcuchy dostaw, systemy logistyczne, logistyczne środowisko, logistyczne podejście.

PROBLEME DER NACHHALTIGE ENTWICKLUNG DER LOGISTIC SYSTEMS IN LIEFERKETTEN

ZUSAMMENFASSUNG. Hintergrund: Die Realisierung von Paradigma der Lieferkette, die viele verschiedene logistische Aspekte betrifft, führt logischerweise, zu der Komplikation der logistischen Systeme. Und das verursacht eine erhebliche Anzahl von der theoretischen wie auch praktischen Problemen. Unserer Meinung nach, haben nicht alle Aspekte der Projektierung und Funktion von logistischen Systemen, die entsprechende Berichterstattung in der heutigen wissenschaftlichen Literatur erhielt. Die spezifischen Probleme von Zusammenbeziehungen der logistischen Systeme mit der Umwelt erforderten eine genauere Betrachtung. Man kann über die Bildung der neuen wissenschaftlichen Richtung (logistic environics) sprechen, als ein Zusatz zu dem klassischen Ansatz zu der Gestaltung von logistischen Systemen.
Methoden: die formalisierte Beschreibung der Zusammenhang zwischen logistischen Systemen und die Umwelt wurde vorgestellt. Dann wurde es von ökologischen, sozialen, wirtschaftlichen, organisatorischen, technologischen, technischen und naturwissenschaftlichen Positionen diskutiert.
Ergebnisse und Fazit: Es gibt eine Wechselwirkung zwischen logistischen Systemen und die Umwelt, erfordert sie aber die Leistung der komplexeren interdisziplinäreren Forschungen..

Codewörter: Lieferketten, Logistik-Systeme, logistische Umwelt, logistischer Ansatz.

Uvarov Sergey
St. Petersburg State University of Economics and Finance
St. Petersburg, Russia

LogForum

> Scientific Journal of Logistics <

ISSN 1734-459X
2011
Vol. 7
Issue 4
No 7

http://www.logforum.net

EFFICIENCY ESTIMATION OF PROCESSES IN SUPPLY CHAIN MANAGEMENT OF PULP AND PAPER PRODUCTION

Tatiana Tereshkina

St. Petersburg State Technological University of Plant Polymers, St. Petersburg, Russia

ABSTRACT. Background: The identification of the impact of complex content characteristics on the effectiveness of supply chains cannot be conducted without a thorough analysis of logistical costs. Pulp and paper industry offers a large variety of products and thus has some specifics of manufacturing. It is characterized by high capital intensity and materials consumption, sophisticated technology and machinery processes domination, and producing a large number of by-products.
Methods: The method of efficiency calculation of logistical processes is used. It is based on the analysis of the logistical cycle parts duration. The logistical cycle duration is divided into periods depending on their increasing or not increasing of the value for the consumer. The analysis of fixed and variable logistic costs in main functional logistic spheres is carried out and the logistic costs influence on operational and financial leverages is estimated.
Results and conclusions: Using the approaches offered to evaluate the effectiveness of logistical processes, the method of calculation logistic leverage and analysis of logistic costs will allow passing on to the definition of given result in the supply chain and to the quantitative evaluation of the total value for the consumer.

Key words: efficiency of logistical processes, value based management, value chain, fixed logistic costs, variable logistic costs, logistical leverage, operational leverage, financial leverage.

It is impossible to identify the impact of complex content characteristics on the ultimate effectiveness of supply chains without a thorough analysis of logistical costs. In the process of analysis, it is worth researching structural and analytical typology of factors affecting logistical costs activating, as well as presenting in a structured fashion industry characteristics of product costs evaluation distinguishing the logistic component.

The aim of this study was to find a method of the evaluation of the effectiveness of logistical processes and the customer value, which is possible to obtain.

Pulp and paper industry (PPI) is the industry sector, which offers a large variety of products and thus has some specifics of manufacturing. It is characterized by high capital intensity and materials consumption, sophisticated technology and machinery processes domination, and producing a large number of by-products [Hong et al. 2011, Hamalinen,Tapaninen, 2011]. The expenditure levels and methods of product costs evaluation are influenced the following industry characteristics:

- availability of product groups, characterized by a homogeneous special manufacturing method. The stages of reprocessing (rework) in each group are feasible;
- a great diversity of homogeneous products by type, brand, grade, and size;
- availability of recyclable and non-recyclable waste, by-product group, and heat sources;

Citation: Tereshkina T., 2011, Efficiency estimation of processes in supply chain management of pulp and paper production. LogForum 7, 4, 7
URL: http://www.logforum.net/vol7/issue4/no7
Accepted: 11.10.2011, on-line: 25.11.2011.

- much water utilization, power capacity, heat capacity and mass capacity of production which requires a great deal of auxiliary services, large areas, and maintenance of an in-plant and out-plant transport;
- large amount of information on the primary accounting of reworks, types of production, as well as division of accounting data on the main and auxiliary industries of principal products, by-products, and wastes;
- logistical costs activating of individual product groups for the entire range of reworks distinguishing the costs of each type or brand;
- ability to use either normative and parametric methods of product costs evaluation and value analysis of product costs or methods of direct account of costs when planning and sorting out the costs by type of product.

It should be emphasized that the management of logistical costs as a separate part of production management in Russia is almost nowhere included into the management system. Moreover, pulp and paper industry, in general, refers to a group of industries the least actively implementing the principles and approaches of logistic management as well as taking into account the logistics component of company's costs Pati, Vrat 2010, Khanduja, Tewari, Chauhan, 2011].

To study the quantity and structure of logistical costs of pulp and paper industry we took Kamenska Paper and Cardboard Factory (PCF). This factory produces 31 grades of paper, 53 and 33 grades of cardboard and corrugated cardboard respectively. The company has established business relations with several hundreds of customers exporting products in different ways. All these characteristics are the evidence of high importance of the logistic component in the factory activities, so the organization of an effective accounting and logistical costs management will give it an additional competitive advantage. The analysis of logistical costs carried out at Kamenska PCF showed that the lion's share of these costs falls on transportation (75%). The remaining costs are the storage ones. Order processing costs and stock management of pulp and paper products are not considered. That is why it is possible to evaluate their significance indirectly only.

Nowadays it is important to ensure accuracy of accounting of both logistical costs and outcomes by type of product, packaging, by various distribution channels, fractions of market, customer groups, individual orders, cost centers and so on. In this respect, there is a problem of reasonable fixed logistical costs sharing according to the units of accounting. The problem under discussion has become more urgent these days, where fixed logistical cost share in the structure of product costs is rising in almost all industries, including pulp and paper industry. The analysis of fixed costs, carried out at Kamenka PCF, showed that almost 70% of all the costs are logistic ones.

Visualization of the structure of the total fixed logistical costs of Kamenska's PCF with decomposition of logistic component is shown in Fig. 1.

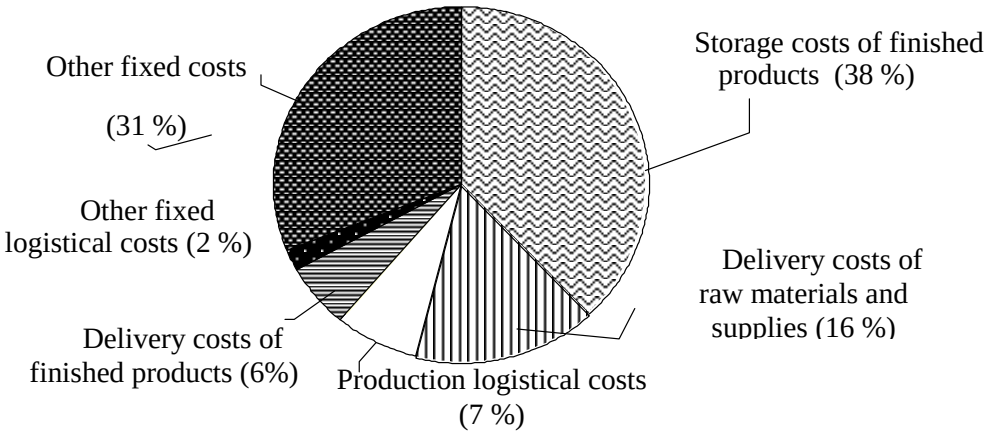

Fig. 1. The structure of fixed costs with logistic component [1 Tereshkina 2009]
Rys. 1. Struktura kosztów stałych związanych z logistyką [Tereshkina 2009]

High ratio of the logistic component of fixed costs demonstrates the significant impact of logistics on the level of operating leverage and, hence operational risk. In order to analyze how logistic costs (LC) influence the level of operational leverage, it is suggested to calculate the following economical indicators:

– S1 - the share of fixed logistic costs in fixed costs of the enterprise and S2 -the the share of fixed logistic costs in total logistic costs:

$$S1 = \frac{LFC}{FC} \quad (1); \qquad S2 = \frac{LFC}{LFC + LVC} \quad (2);$$

LFC - fixed logistic costs,

LVC - variable logistic costs,

FC - fixed costs.

– PFC - the ratio of net profit (NP) to fixed costs and PLFC -the ratio of net profit to the fixed logistical costs:

$$PFC = \frac{NP}{FC}(3) \qquad PLFC = \frac{NP}{LFC}(4)$$

Operating leverage (OL) shows the degree of sensitivity of profit to changes in the volume of output in natural units. After transformations of OL formula, one can see that the degree of operating leverage depends on ratio of fixed costs and operating profit. A similar ratio can be defined for the fixed logistical costs, provided that the ratio wherein the numerator is separated into logistical and non-logistical fixed costs. Thus, we can reveal the impact of logistics on the operational risk of the enterprise. By analogy with operating leverage it is possible to determine the influence of logistics on financial risk, which is defined by financial leverage (FL).

The level of financial leverage is much influenced by amount and turnover of inventories. These indicators of Russian pulp and paper mills are less than the same in developed countries. Table 1 shows significant immobilization of capital stock, as their turnover of inventories ranges from 38 to 60 days (but according to foreign pulp and paper mills, it should take from 15 to 22 days). The level of financial risk increases when volume-related capital is rising. Hence, it is necessary to reduce the cost of capital invested in current assets of all the supply chain.

Table 1. Turnover of inventories (average indicators for the period of 2005 - 2008)
Tabela 1. Rotacja zapasów (średnie wskaźniki za okres 2005-2008)

Indicator	**'Nemansky Pulp and Paper Plant'**	**'Kotlassky Pulp and Paper Plant'**	**'Kamenska paperboard plant'**	**'Saint-Petersburg cardboard mill'**
1. Share of current assets in total assets (%)	70	46	44	41
2.Share of inventories in current assets (%)	46	25	22	43
3. Inventories turnover in days	60	38	35	50

Enterprises should draw up a "map" of asset flow, which shows the volume of capital and period of freezing of current assets at each stage (Table 2). Using such schemes one can see what steps could

lead an enterprise to improve processes and reduce costs and, consequently, to decrease in the debt capital for working capital, and so to reduce financial risk.

Table 2. Analyses of significance of immobilization of capital stock at PC 'Kotlassky Pulp and Paper Plant' [Tereshkina 2009]

Tabela 2. Analiza istotności zamrożenia kapitału akcyjnego w firmie 'Kotlassky Pulp and Paper Plant' [Tereshkina 2009]

Indicators	Purchase of raw materials and supplies	Production	Storage of finished products	Transportation	Accounts receivable
Inventories turnover, days	23	3	12	2	25
Capital, millions of rub.	100,9	12,5	48,6	130,7	146,0
Volume of immobilized capital, millions of rub.	6,44	0,09	1,56	0,72	10
Opportunity to reduce the costs (volume of immobilized capital/inventories turnover), millions of rub.	0,28	0,03	0,13	0,36	0,40

Logistical factors highly influence the operational and financial leverages because of the following reasons:

- a high share of logistic component of fixed costs demonstrates the significant impact of logistics on the level of operational risk;
- logistic component of the financial leverage is expressed primarily in amount and turnover of inventories. The higher these factors, the more the debt capital for working capital of an enterprise, thus the more the financial risk;
- the worse the relationship with suppliers and customers, amount and turnover of inventories. the more the of receivables and payables. This influence directly the structure of source of finance, that is, the financial leverage;
- to manage the operational and financial leverages and, hence, the risk involved, and to identify the influence of logistic factors, first of all, means to control the dynamics of this indicators and to ensure the safety margin in terms of excess marginal income over the level of fixed costs.

A leverage ratio that summarizes the combined effect of the degree of operating leverage (OL), and the degree of financial leverage (DFL) is called degree of combined leverage (DCL). It is calculated as a results of multiplication of OL and FL.

Here is the formula for calculating the level of logistic leverage (LL), which is the modified formula of degree of combined leverage [Tereshkina 2009]:

$$LL = \frac{\left(P - \frac{LVC+OVC}{Q}\right) * Q}{\left(P - \frac{LVC+OVC}{Q}\right) * Q - (LFC+OFC) - N} \quad (5)$$

where:

P - unit price,

Q - volume of production,

N - interests,

OFC and OVC - other (non-logistic) fixed and variable costs.

When defining the level of logistic leverage, it is more important to analyze the rate of change indicators than its values. In such a manner, using the proposed indicators one can define the impact of logistics on the operational and financial risks of an enterprise. Identification and analysis of the amount and structure of logistical costs, when dividing them into fixed and variable, along with ensuring accuracy of accounting of both logistical costs and outcomes by type of product, packaging, by various distribution channels, fractions of market, customer groups, individual orders, and cost centers will allow to move to evaluation of effectiveness of supply chains. To do that, it is essential to evaluate critically every process and every activity in the supply chain and answer the following question: 'Does such type of activity increase the value of the goods or of the costs?'

Each element and each relation of the logistics chain should be carefully examined with respect to values and costs created by them. By value in this context, we mean customer loyalty, i.e. contribution into improving the product benefits or special offers to the clients, which make them, be happy and return to purchase again.

It should be noted that a considerable part of time spent on customer satisfaction is excessive and its reduction would increase consistency and reliability of services, and thus increase public image.

The difference between the time that increases the value and the time, which does not add value, is key to understanding the possibilities for the improvement of logistics processes. [Kristofer 2004]. A Table 3 illustrates the analysis of duration of the logistical cycle of production and sales of products of goffered at Kamenska paperboard plant.

Table 3. Logistical cycle duration of production of products of goffered at Kamenska paperboard plant
Tabela 3. Okres cyklu logistycznego produkcji w zakładzie Kamenska

Logistical cycle components	Logistical cycle duration, days		
	Total	which includes	
		increasing value	not increasing value
Transportation of raw materials and supplies	3	3	-
Inventories of raw materials and supplies	22	-	22
Production	2	2	-
Inventories of unfinished production	4	-	4
Production	1	1	-
Inventories of finished products	9	-	9
Transportation of finished products to the customer	2	2	-
TOTAL	43	8	35

As can be seen from this table the overall time of the process is equal to 43 days, and the added value is created only for 18,6% of the duration of this period. Efficiency of logistical processes (ELP) is defined as the time increasing value (T_v) to the total time of duration of the logistical cycle (T_{total}), expressed as a percentage.

$$ELP = \frac{Tv}{Ttotal} * 100\% \quad (6)$$

So, most of the time the goods in the supply chain do not provide the increase in value. To improve this efficiency indicator, above all, it is necessary to achieve full understanding of the processes and activities related to the companies forming the supply chain, and this should be possible in case of drawing up a scheme of the supply chain. Such a scheme is a reliable tool for logistical re-engineering.

The data presented in Table 3 give an idea only on duration of the individual components of the logistical process, though, a quantitative evaluation of this "value" is not presented.

SUMMARY

Using the approaches offered to evaluate the effectiveness of logistical processes and analysis of logistic costs will allow passing on to the definition of given result in the supply chain and to the quantitative evaluation of the total value for the consumer.

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OCENA EFEKTYWNOŚCI PROCESÓW W ZARZĄDZANIU ŁAŃCUCHEM DOSTAW W PRODUKCJI CELULOZY I PAPIERU

STRESZCZENIE. **Wstęp**: Identyfikacja wpływu złożonych charakterystyk na efektywność łańcucha dostaw nie może być przeprowadzona bez dogłębnej analizy kosztów logistycznych. Przemysł drzewny i papierniczy charakteryzuje się dużą ilością oferowanych wyrobów oraz pewną specyfiką produkcji. Charakteryzuje się on wysoką kapitałochłonnością oraz dużym zużyciem materiałów, skomplikowaną technologią oraz dużą ilością produktów ubocznych.
Metody: Przedstawiono metodę obliczania efektywności procesów logistycznych, opartą na analizie czasu trwania logistycznych części cyklu. Logistyczny czas trwania cyklu został podzielony na okresy w zależności od ich udziału w zwiększaniu lub nie zwiększaniu wartości konsumenckiej. Wykonano analizę stałych i zmiennych kosztów logistycznych w głównych funkcjonalnych obszarach logistyki oraz zdefiniowano wpływ kosztów logistycznych na dźwignie operacyjne i finansowe.
Wyniki i wnioski: Zastosowanie metody proponowanej do obliczania efektywności procesów logistycznych, metody obliczania dźwigni logistycznej oraz analizy kosztów logistycznych pozwala na ocenę uzyskanych wyników dla łańcucha dostaw oraz na ilościową ocenę całkowitej wartości konsumenckiej.

Słowa kluczowe: efektywność procesów logistycznych, wartościowe zarządzania, łańcuch wartości, stałe koszty logistyczne, zmienne koszty logistyczne, dźwignia logistyczna, dźwignia operacyjna, dźwignia finansowa.

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BEWERTUNG DER EFFEKTIVITÄT DER PROZESSE IM LIEFERKETTENMANAGEMENT IN DER CELLULOSE- UND PAPIERHERSTELLUNG

ZUSAMMENFASSUNG. Hintergrund: Die Identifizierung des Einflusses komplexer Charakteristika auf die Effektivität der Lieferketten kann nicht ohne eine tiefere Analyse der Logistikkosten durchgeführt werden. Die Holz- und Papierindustrie zeichnet sich durch eine hohe Vielzahl der angebotenen Erzeugnisse und Produktionsspezifik. Charakteristisch für diese Industrie sind: die hohe Kapitalintensität, großer Materialverbrauch, komplizierte Technologie und eine Vielzahl von Nebenprodukten.
Methoden: Es wurde eine Methode zur Ermittlung logistischer Prozesse dargestellt, die auf Analyse des Logistik-Zeitzyklus basiert. Der Logistik-Zeitzyklus wurde in Perioden, abhängig von deren Teilnahme an der Steigerung oder Nichtsteigerung des Kundennutzens, aufgeteilt. Es wurde die Analyse fixer und variabler Kosten in den grundsätzlichen funktionellen Logistikbereichen durchgeführt und der Einfluss der Logistikkosten auf den operativen und finanziellen Hebel definiert.
Ergebnisse und Fazit: Die Anwendung der Methode zur Ermittlung der Effektivität logistischer Prozesse, der Methode zur Berechnung des Logistikshebels und Analyse der Logistikkosten ermöglicht die Beurteilung der erzielten Ergebnisse für die Lieferketten sowie eine mengenbezogene Beurteilung des gesamten Kundenwertes.

Codewörter: Effektivität logistischer Prozesse, Wertkette, fixe und variable Logistikkosten, Logistikhebel, finanzieller Hebel.

Tatiana Tereshkina
Dr. sc., Professor
Dean of Economics and Management Faculty,
Head of Marketing and Logistics Department
St. Petersburg State Technological University of Plant Polymers
St. Petersburg, Russia
e-mail: ttp_big@mail.ru