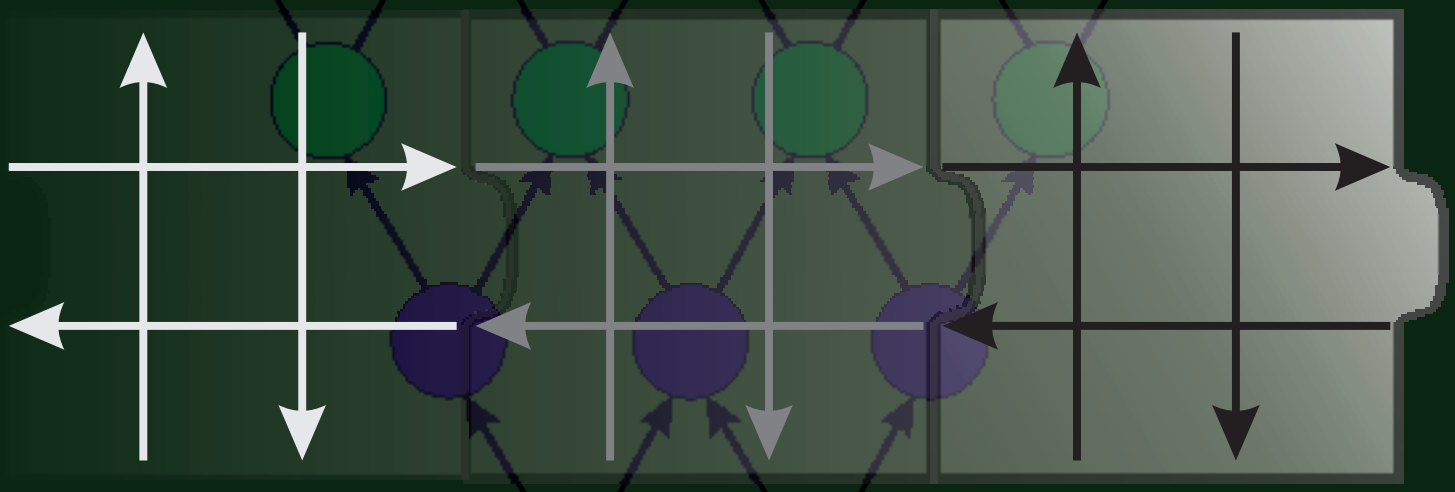
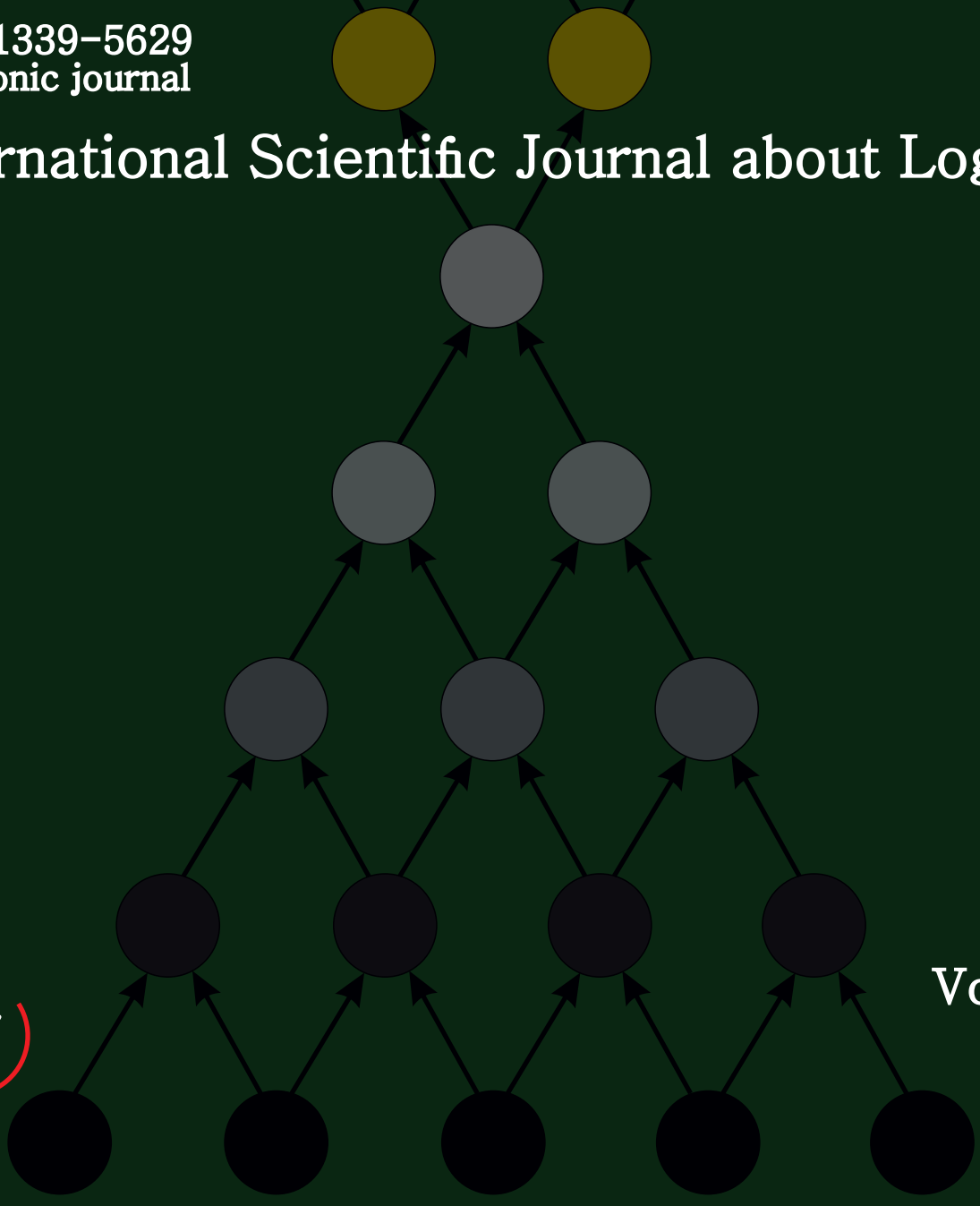
# ACTA LOGISTICA



ISSN 1339-5629
electronic journal

International Scientific Journal about Logistics



Volume 1
Issue 2
2014

# CONTENTS

**(JUNE 2014)**

# OPPORTUNITIES TO INCREASE OF ESTABLISHMENT´S COMPETITIVENESS APPLYING RESOURCES OF INFORMATION LOGISTICS IN THE CONCRETE COMPANY´S ENVIRONMENT

**Kristína Ignáczová**
TU of Košice, Faculty BERG, Logistics Institute of Industry and Transport, Park Komenského 14, 043 84 Košice, Slovakia, kristina.krizanova@student.tuke.sk

***Keywords:*** competitiveness, information logistics, information flow, website
***Abstract:*** This article solves the problem about ensuring and managing of the information flow by the institution for higher education – the Technical University of Košice (TUKE) and one of its faculty, the Faculty of Mining, Ecology, Process Control and Geotechnology (FBERG). It is paid attention to the university´s official website and its complicacy. TUKE homepage is chosen for the primary source of information and the article explains the opportunities of its improvement for the purpose of streamlining the information behavior of both organizations. The implementations of concrete solution´s offer expects an increasing of organizations´s competitiveness that will promote the status and awareness of the organizations in society.

## 1 Introduction

Information offer via the organizations´s web presentations are now becoming a basic communication tool between organizations and society. For this reason is searching of information in an electronic environment a part of everyday human information behavior. Therefore is appropriate to pay attention to the way of their providing and promotion. In this case goes a promotion of univesity hand in hand with raising the quality of learning, academia, researches and care for graduates´s future.

Offer of institutions for higher education is wide. A competition is a mover of any business and refers to a situation in a market in which firms or sellers strive independently for the patronage of buyers [1]. Competitive are products, firms, nations, offers and services that meet the quality and prices standards of the local and world market [2]. Information flow in the speech, documentary and other forms is between the external environment and internal logistics environment, and its main function is the realization of management function [3]. Information offer via the organizations´s web presentations shows over the years a progress. Nowadays user requirements are dynamic, interaction, usage of multimedia elements, searching concepts and variables, own account, online interfaces, electronic payments etc. Older website types are static pages. These meet only the requirements of easy obtaining of informations.

## 2 Analysis of the actual status of Technical university of Košice and Faculty BERG

The establishment of Universitas Casoviensis in Košice in 1657 was essential for education enhancement of Hungarian dwellers. 105 years after this establishment was the technical education promoted to the higher level. In 1952 came to the establishment of the Košice Technical College. Since 1991 is this institution of higher education renamed as Technical Univesity of Košice (TUKE). In spite of this rich history has the university never been named "Slovak" or "State", however it was planned. Pre-war events following the Vienna Arbitration caused the college moving to Bratislava, the basis for the Slovak Technical University in Bratislava [4].

TUKE offers education in wide variety of study programmes with a practical use in the region of its Alma mater. It is also necessary to say that the study is provided by nine faculties. The comparison of specifications of faculties technical universities in Slovakia, Czech Republic and Poland found, that the TUKE faculties´s and their institutes´s structure are unique. It can be said that five of nine faculties are unrepeteable and could be used for "building blocks" in creating competitive advantage.

In this case are TUKE and FBERG reviewed independently, but both are staff and line organizational structure. Information flow is excessively complicated due to numerous subordinate departments. [3] Vice-deans of FBERG are responsible not only for scientific and research activities but also for many flows that provide informatisations and promotion of university in society.

TUKE accepted in 1996 the border of the students number (9000). This number increased until 2009 (to more than 17600). Equally important are facts about FBERG. The number of registered FBERG students is falling and doesn´t meet planned number of admitted applicants, however the real number of admitted applicants is sufficient to meet the planned number.

Over the academic years 2007/2008 – 2012/2013 were variable numbers of study programmes in both organizations. For example, in the 1st level of internal and external form changed TUKE this number every academic year. As for the FBERG, it wasn´t retain same number in two from six academic years.

**OPPORTUNITIES TO INCREASE OF ESTABLISHMENT´S COMPETITIVENESS APPLYING RESOURCES OF INFORMATION LOGISTICS IN THE CONCRETE COMPANY´S ENVIRONMENT**

Kristína Ignáczová

Since 2004, Academic Ranking and Rating Agencyhas rated the quality of slovak higher education insitutions. TUKE and FBERG have been included in this ratings. There are several categories to rate: Science and research, Education, Funding and Reputation. Both organizations are classificated in so called class "TECH" separately. The FBERG achieved the best rate in the first year of rating (4$^{th}$place). The most unfavorable rate came five years after that (17$^{th}$place) and this fact causes a soft regress in global evaluation about the TUKE in this class. After 2010 are realized evaluations just about the faculties of higher education institutions. The last ranking of FBERG achieved 11$^{th}$place – the year 2013.

### *2.1 Character of information support*

In the organizations´s legislation are included, among others, methods to ensure information systems. The aim of the operating instructions for computer network TUNET and TUKE information system is to establish a compact agenda for building and operation for information support. The homepage for TUKE is *www.tuke.sk.*


*Figure 1 Homepage design in October 2005 [5]*


*Figure 2 Homepage design in February 2014*

From a first look is clear that a university communicates with applicants via heading: Challenge for your future. Except design changes it comes to content changes too. There were also added separate sections as: For students, For employees, For applicants, News, University Highlights, etc. Quite positive is the fact that over the years it has come to changes. TUKE has its own sources for ensuring a web page. The server www.tuke.sk is created and operated not by some external supplier, but by one part of TUKE, by the Institute of Computer Technology. The common web presentation part of almost every institution of higher education is redirection to its, so called, "fan page" on social network Facebook. Nowadays, this redirection is missing from TUKE homepage and furthermore it also doesn´t exist any serious TUKE fan page on this social network.

Another, but no less important is the fact that homepage www.tuke.sk is included in the "Webometrics Ranking of World Universities". This ranking web of universities contains about 12 000 web presentations of universities from over the world. According to recent data (March 2014) the homepage is ranked 3$^{rd}$ place within Slovakia. In the global ratings surpasses TUKE homepage nearly 90% of all evaluations (1199$^{th}$place).

### *2.2 Results of opionons and preferences from TUKE applicants*

The main goal of survey was focused on the information problem and it connected potential applicants for the study with the content of available information and technology. The survey was realized during the Open day TUKE in November 2013 and contained 7 questions. For the purpose of the bachelor thesis there got onto 50 potential TUKE applicants. Two from completed questionnaires were classified as invalid. Nowadays, the number 48 of real applicants presents only 1% of applicants for 1$^{st}$ level of internal and external forms. In spite of this fact are survey results considered for general valid.

First question was focused on kind of faculty in which are applicants interested. The most of applicants, 33%, is going to apply on the Faculty of Electrical Engineering and Informatics. According the survey is the FBERG the second favourite faculty, where is going to apply 22% of applicants. The server www.tuke.sk was chosen for information source by most of applicants in the second question.The third question divided applicants into two groups – applicants, who have ever visited TUKE homepage and applicants, who hadn´t visited TUKE homepage yet. A first group covered 85% of applicants and could continue in survey. The rest of applicants were requested to give back a survey. Answers on fourth question are quite unexpected because the most of applicants browse the section – For students. Only 30% of them are interested in the section – For applicants. Answers on next question reveals the facts about the satisfaction with TUKE homepage clarity. Almost 60% of

applicants are with homepage clarity satisfied. It is also necessary to add result of sixth question, that according survey results takes each visitor some benefits from the homepage visit, but most of them would rather find out more information. The last survey question asked for study programmes which are offered by the FBERG´s Logistics Institute of Industry and Transport. It was asked for the ability to arouse interest and the following selection, which was based only on naming of study programmes. Study programmes of a Logistics Institute (Traffic management of raw materials, Industrial logistics, Transport logistics of company) are chosen only by few of applicants. Other study programme (Technology and transport management) arouses the interest in most of applicants.

## 3 Weaknesses specify and appropriate solution´s offer

Opportunities to increase the competitiveness of the TUKE and FBERG with applying resources of information logistics couldn´t be neglected. Changes in information logistics and information behaviour could increase the competitiveness of organizations and bring benefits in competitive environment of universities. The informedness, availability and clarity of informations is the "primary language" of communication between organization and society. An effective way of competitiveness increasing is ability to meet expectations of this communication.

### *3.1 Dynamic strategy as method to ensure and manage informations on web page*

The main aim TUKE homepage is to express – who the university is and what it offers. Web environment of competitive institutions tries to influence and persuade a user. At first sight is clear that other universities try to express why the university is so special and that also exists a value added for study there, although, it should be paid for the study. This effect is caused by information logistics strategy.

As standards for TUKE homepage should be set up dynamic elements, visitor interaction (e.g. to provide storage already visited links), modernization of homepage structure and visual character of documents (e.g. header and other multimedia variation, attractive graphic elements).

It is also necessary to point out that the page footer contains redirections to websites of the faculties. A benefit for website clarity could be relocation of this redirections on the top or sides of web document.

When it comes to redirections more - What kind of source should more inform about interesting cooperation among university and organizations? At the homepage could be added not only information about cooperations, but also links to web pages of companies, scientific and research institutions, etc., that TUKE or faculties worked or still work with. A creating serious TUKE fan page on social network and redirection from TUKE homepage will be advantageous in many ways for ensure information flow.

TUKE should pay attention to its network´s infiltrations and potential infiltrations that parasitize in data mediums of students, academia and TUKE guests. An quality antivirus software with many security solutions can provide access to all information flows.

### *3.2 Stimulating awareness of the university*

An effective and targeted promotion is an useful and essential way of stimulating awareness of the university in society. A possible solution to relieve responsibility vice-deans of faculties is ensuring a competent person at keeping awareness and promotion study at the TUKE.

When it comes to ensuring of information flow, there aren´t noticed any promotional incentives or advertisement in radio, TV, newspapers or on billboards. Also survey results show that nobody of the applicants chose radio, TV or the book "Before starting the university" for information source about the university and study programmes. This fact is important because it is spent fund for promotion and advertising of studium at TUKE every year. According to recent data (academic year 2012/2013) it was spent more than 100 thousand Euro for this purpose. To imagine, 490 Euro costs advertisement for 30seconds that is aired at a time 12:00PM to 6:00PM on radio (the Funradio). An 1minute TV advertisement costs 1500 Eur and is shown at 8:10PM on RTVS, etc.

Some ways of the university promotion could be effectively keep also on the TUKE homepage. For example, publishing of parts of academic works and knowledges are opportunities for increasing awareness of the university in society. As a feedback to explorations and evaluations about TUKE could be added own statements and alternatively, what for steps will be taken to improve evaluations´s results.

### *3.3 Promotion through students, study programmes and TUKE uniqueness*

In the long term is number of foreign students at TUKE around 120 – 160 for one academic year. TUKE and FBERG should add into their activities also ways, that will help to increase the interest of students from foreign countries. Of course, it takes time and demands skilled academia, translations, approving of study programmes, etc. However, far more important are opportunities, that these students bring with. They can share skills and experiences in their homeland and therefore will be TUKE promoted in abroad without any (targeted) funds for advertising and promotion.

The Institute of Information and Prognoses of Education informs that planned numbers of admitted applicants at FBERG are significantly greater than numbers of registered applicants in the long term. In terms of information logistics can be made several steps

to improve this, at first sight, - information problem. A making decision about admitting, delivering of application process results and registration should be organized in the fastest as possible. In this case is necessary to avoid other offers of competitive universities - to inform and organize registration earlier.

The competitiveness of the university is influenced by naming of study programmes, that was also demostrate by result on the last question of survey. Actually offer of study programmes of the Logistics Institute of Industry and Transport, in survey selected according the naming, shows signs of unatractivity. Because of this fact, it is profitable to think about naming of this study programmes. In this context is important to mention the reliability to graduate the study programm, what is related with request of the permanent (or increasing) number of study programmes.

When it comes to offer of study programmes closer, it could be modificated way to the firs contact (via the Internet) between the university and applicant.

Quite common on the web presentations are unusual expressions about definition of study programmes. A bulleted list is nowadays used rarely and it is modificated to direct speech of students or academia. In student´s direct speech can be mentioned benefits, projects, interesting excursion, favourite subjects, etc. Through this way can an applicant feel more addressed and can more understand the definition of study programme. It is called cooperation in this context.

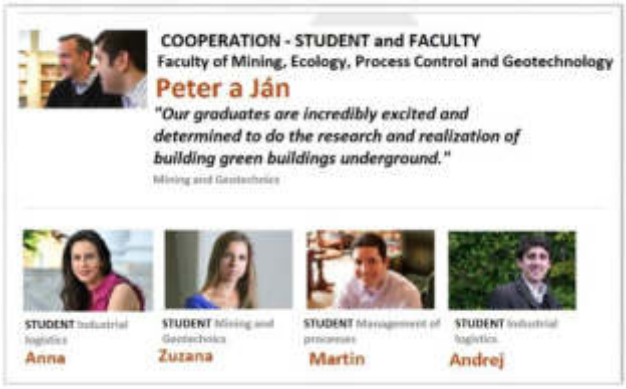



*Figure 3Cooperation – student and faculty (engl. version)*

Searching of information via some search engine is very popular. This way of searching can be implemented in method for inform about study programmes offer. A search engine can be programmed for searching according to requested word, faculty, forms of study, subjects, etc. The basic character of displayed document can show faculties in frames colored according faculty´s specific colours. In the frames can be included also short definitions about each study programme.

The other opportunity for TUKE homepage is to offer a test. This test could explain applicant´s study interest according his/her answers on test´s questions. Answers should lead to a concrete study programme and this result can be used as direct recommendation for studium at TUKE.

## Conclusion

Increase of competitiveness of TUKE and FBERG is possible by implementation of improving changes in application by resources of information logistics, which are presented in this article. It has been shown that primary assumption for browsing informations is availability and clarity of information sources. Fulfilling the basic postulates brings appropriate answers to information requirements and satisfaction with need for information. This action ensures the relevance of the information flow and also the purpose of information logistics. The implementation of modern, attractive and interactive ways of TUKE web communication can meet the habits and expectations of information behavior of young generation of today´s society. The most of mentioned changes can be realized immediately and without special costs. This is possible because the TUKE information support and web presentation are ensured by TUKE staff. The significance of ensuring this kind of communication is proved by the fact, that over 85% of applicants visit the TUKE homepage www.tuke.sk.

## References

[1] http://stats.oecd.org/glossary/search.asp
[2] http://www.businessdictionary.com/definition/competiveness.html
[3] BALOG, M., STRAKA, M.: *Logistické informačné systémy.* Bratislava: EPOS, p. 208, 2005.
[4] http://www.tuke.sk/tuke/univerzita
[5] http://www.tuke.sk/legislativa/sekcia-pre-zamestnancov/dizajn-manual/tuke_dizajn_manual_verzia_1-11-2005.pdf
[6] PORTER, E. M.: *Konkurenční výhoda.* Praha: Victoria Publishing a.s., p. 626, Translated form am.original: Competitive advantege., 1993.
[7] STRAKA, M., BALOG, M., IŽOLOVÁ, J.: *Informačná logistika a informačné systémy.* Košice: Edičné pracovisko – Fakulta FBERG, p.110, 2010.
[8] CEDERHOLM, D.: *Webdesign s webovými standardy.* Brno: Zoner software s.r.o, p. 256, 2004. Translated from am. original: Web standard ssolutions: The mark up and style hand book.
[9] PÓLYA, A.: *Webové stránky a netradičné formy vzdelávania v informačnej spoločnosti.* Bratislava: Ekonóm, p. 80, 2008.
[10]http://www.tuke.sk/legislativa/sekcia-pre-zamestnancov/prevadzkovepredpisy/PvP_TUKE_PSIS_09_Pocitacovej_siete_TUNET_a_IS_TUKE_Vyd01zmk01.pdf
[11] http://www.w3.org/Consortium/mission
[12] http://webometrics.info/en/Europe/Slovakia
[13] ECCHER, C.: *Profesionální webdesign techniky a vzorová řešení.* Brno: CP Books, a.s., p. 420, 2005.

[14]STEINEROVÁ, J., GREŠKOVÁ, M., ILAVSKÁ, J. *Vyhľadávanie informácií a organizácia poznania v elektronickom prostredí* [online]. Bratislava: FIF UK, 2010. <http://stella.uniba.sk/texty/VIOPvEP.pdf>

[15] STEINEROVÁ, J., GREŠKOVÁ, M., ILAVSKÁ, J.:. *Informačné stratégie v elektronickom prostredí.* Bratislava: Univerzita Komenského v Bratislave, p. 192, 2010.

[16] BASL, J.: *Podnikové informační systémy - podnik v informační společnosti* 2.,výrazně přepracované a rozšířené vydání. Praha: Grada Publishing, p. 283, 2008. http://books.google.sk/books?id=woSiPpuZAaMC&hl=sk&source=gbs_ViewAPI&redir_esc=y

[17] RUSSEV, S., Russev, R.*: Informačná podpora manažmentu výrobných podnikov.* Bratislava: Univerzita Komenského Bratislava, p. 168, 2011.

[18] http://www.tuke.sk/tuke/univerzita/organizacna-struktura-tu-v-kosiciach/TUKE_org_struktura_od_1_6_2012.pdf

[19] KUBASÁKOVÁ, I., KAMPF, R., STOPKA, O.: *Logistics information and communication technology.* Komunikacie 16 (2), p. 9-13, 2014.

[20] LOUČANOVÁ, E.: *Inovácie ako podmienka konkurencieschopnosti drevospracujúceho priemyslu na globálnom trhu.* In Inovace: jediná účinná cesta k úspěchu v globální ekonomice. Praha : Soukromá vysoká škola ekonomických studií, s.r.o., p. 102-105, 2005.

[21] DANILÁK, Michal: *Ochrana informačného systému školy pred počítačovými vírusmi.* In: Informačné systém pre manažérov a školy: Zborník príspevkov z odborných seminárov, Košice: Dom techniky ZSVTS Košice, spol. s.r.o, p. 72-79, 1994.

**Review process**

Single-blind peer reviewed process by two reviewers.

# ANALYSIS AND ASSESSMENT OF RISKS ASSOCIATED WITH CONSTRUCTION OF THE ROAD INFRASTRUCTURE IN SLOVAKIA

**Dávid Šimko**
TU of Košice, Faculty BERG, Logistics Institute of Industry and Transport, Park Komenského 14, 043 84 Košice, Slovakia, dav.simko@gmail.com

***Keywords:*** risks, construction, road infrastructure, Slovak republic
***Abstract:*** The article analyzes the risks associated with the process of constructing the road infrastructure. It´s showing us how many different types of risks threats this process and what can happen if we ignore them. In the article are these risks divided in different groups according to the place in this process where they arise, they are also singly defined and described. In the end of the article is possible to find different proposals for the elimination of these risks and also there are mentioned a few reasons why is building of the road infrastructure in Slovakia so slow.

## 1 Introduction

Risk is danger of creation of adverse events, such as loss, damage, failure, with some probability with which these events may occur.

Risk = uncertainty x adverse effect

Risk = danger / preventive measures

From these relations, we can understand that risk can´t be zero. Awareness of risk reduces this risk and with implementation of preventive measures we can successfully even more reduce this risk[1].

### *1.1 The general process of risk assessment*

General process of risk assessment is possible to define via this algorithm.

The first step is defining the system in which we operate and in which some risks and dangerous situations can arise. The second step is identifying dangers in this system and they´re possible consequences if they are fullfilled, what means identifying the hidden attributes of some objects or activities which can cause damages.

If we defined the possible consequences properly the next step is risk assessment which is a function of probability of an undesirable situation and the severity of consequences if the danger is fullfilled.

The next step is risk rating and considering if the risk is acceptable for our situation and whether we are willing to continue the process with this risk. If the risk is acceptable the assessing ends and realisation of the project can start. If it isn´t, the task is to find appropiate measures to reduce the risk and after aplication of this measures the algorithm starts again with new inputs.

This algorithm can be recurrent until the risk reducing measures will not bring us the wanted results and until the risk doesn´t become acceptable.

This algorithm is ilustrated there:

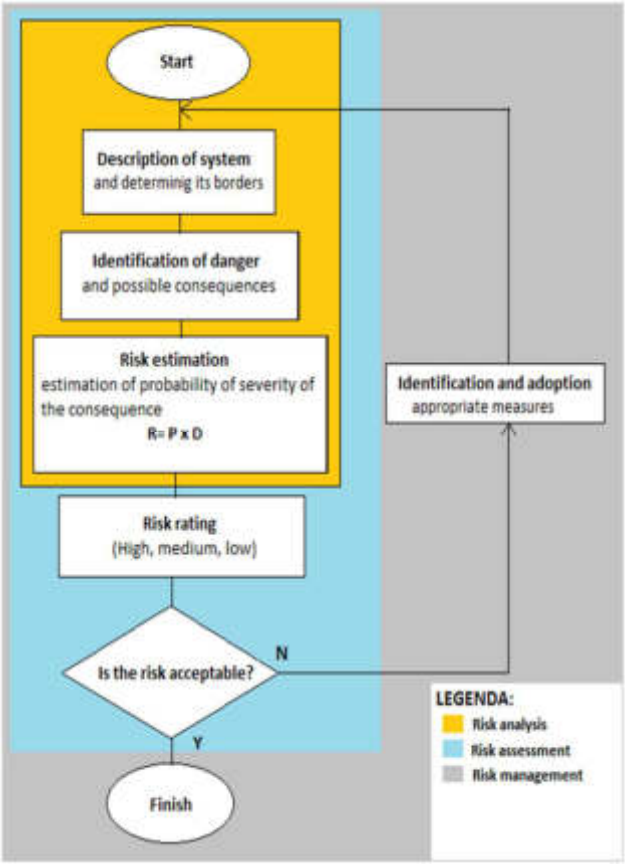



*Figure 1 Algorithm of the general process of risk assessment*
***Author:*** *Dávid Šimko*

### *1.2 Crisis management*

Crisis management as an actiity is a set of measures and acts focused on solving emergency situations by using specific principles, methods and procedures to overcome its adverse effects and restore original functions of the system [2].

Crisis management as an institution is a system of workers or authorities who analyze the possibility of crisis situations in this system, their causes and possible

consequences as well as finding methods and measures for crisis prevention and elimination existing crisis situations[2].

Basic tools of crisis management:

- Crisis thinking
- Crisis management system
- Crisis planning
- Crisis communication

**Crisis thinking**

One of the most important tools of crisis management is crisis thinking. It understands the necessity of creation crisis situations and accepts the necessity spending funds on preventive measures and removing negative effects of crisis situations. Forming of the crisis thinking, its success with solving crisis situations and the crisis communication level depend on crisis management. Crisis thinking together with crisis communication creates a functional connection between company and crisis management [3].

**Crisis management**

Is formed by horizontal and vertical structure of managing and executive authorities, their function and scope, connection and mutual relations, activities, legal environment, tools and technical and technological equipment. Crisis management performs preventive function and also implementation function. Some of its elements works permanently, others only during solving crisis situations [3].

**Crisis planning**

The aim of crisis planning is to collect all the needs and requirements that are necessary for dealing with crisis situation but also to create an overview of available resources and compare them with the identified requirements. With this, crisis planning creates good conditions for successful intervention and minimalization of damages [3].

**Crisis communication**

On the one hand, it has an important role in true and full informing right persons about emergency preparations and on the other hand in informing about emergency situations and their course. There must be also some kind of backup communication and information system to preserve the continuity of ongoing processes in case of failure of the primary communication channels[3].

### *1.3 The general procedure of road construction*

The whole process of construction of the road infrastructure from the first step can be summarized in following points:

1. **Pre-investment preparation:**
   - **a.** Process of engineering research
   - **b.** Process of EIA (Enviromental impact assessment)
   - **c.** Development plan
   - **d.** Reporting on the evaluation report, final attitude of the EIA process
   - **e.** Route stabilization in spatial plans of municipalities and higher territorial units
2. **Investment preparation and project preparation:**
   - **a.** Preparation of building project and documentation for zoning
   - **b.** Zoning decision about the building location
   - **c.** Documentation for planning permission
   - **d.** Decision about permanent set-aside of agricultural land and forest land
   - **e.** Ownership and legal settlement (purchase and expropriation)
   - **f.** Planning permission
3. **Realisation and construction:**
   - **a.** Tender documentation
   - **b.** Choosing a construction contractor through tender
   - **c.** Transfering the building place to construction contractor
   - **d.** Complex regulatory activities of construction works
   - **e.** Designer´s supervision
   - **f.** Acceptance procedure
   - **g.** Documentation of actual state of the finished building
   - **h.** The building approval procedure
   - **i.** Final technical and economic assessment of the completed public work
4. **Transfering the stewardship or ownership**
5. **Using [4]**

### *1.4 System of construction of the road infrastructure*

Proper operation of the this system depends on proper operation of all its elements, as shows the following figure:

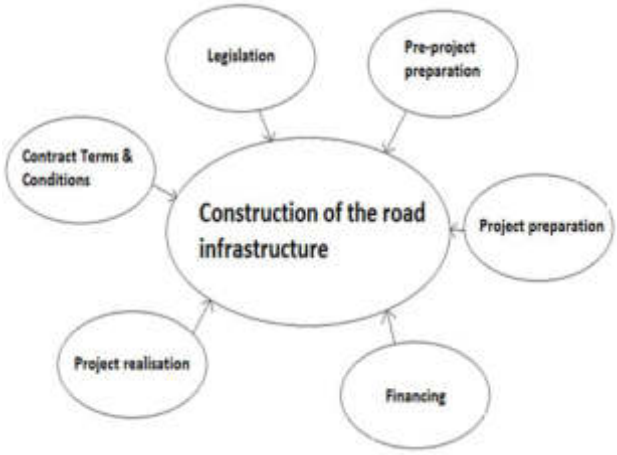



*Figure 2 System of the construction of the road infrastructure*
***Author:*** *Dávid Šimko*

## 2 Schedule of risks associated with construction of the road infrastructure

Following shedule shows how many risks are associated with contruction of the road infrastructure through PPP projects and in which category they belong:

**ANALYSIS AND ASSESSMENT OF RISKS ASSOCIATED WITH CONSTRUCTION OF THE ROAD INFRASTRUCTURE IN SLOVAKIA**

Dávid Šimko

1. **CONSTRUCTION, TECHNOLOGICAL AND PROJECT RISKS**
   - **1.1 Construction and project risks**
     - **1.1.1.** The risk of project documentation
     - **1.1.2.** The risk of construction / building
     - **1.1.3.** The risk of construction costs overruning
     - **1.1.4.** The risk of contamination of the environment during project implementation
     - **1.1.5.** The risk of project impact on the environment during the projects lifetime
   - **1.2 Risks of locality**
     - **1.2.1.** The risk of an existing object
     - **1.2.2.** The risk of availability of the locality
     - **1.2.3.** The risk of the locality ownership
     - **1.2.4.** The risk of locality condition
     - **1.2.5.** The risk of an existing utilities in the construction locality
     - **1.2.6.** The risk of the zoning plan
     - **1.2.7.** The risk of the planning permission
     - **1.2.8.** The risk of cultural or archaeological heritage
     - **1.2.9.** The risk of protected natural area
   - **1.3 Risks of faulty technologies, utilites and related services**
     - **1.3.1.** The risk of mistakes during project realisation
     - **1.3.2.** The risk of mistakes during the projects lifetime
     - **1.3.3.** The risk of faulty technology
     - **1.3.4.** The risk of technological inadequancy
     - **1.3.5.** The risk of an unexpected power, tilities or support system failures
2. **CREDIT RISKS**
   - **2.1 The risk of liquidity**
   - **2.2 The risk of failure to fulfill obligations/availability risk**
     - **2.2.1.** The risk of failure to fulfill the obligations by private sector
     - **2.2.2.** The risk of failure to fulfill the obligations by public sector
     - **2.2.3.** The risk of failure of the cuonterparty
     - **2.2.4.** The risk of concentration
     - **2.2.5.** The risk of partnership rejection
3. **MARKET RISKS**
   - **3.1. The risk of demand**
   - **3.2. The risk of favoring the rivals**
   - **3.3. Other market risks**
     - **3.3.1.** The risk of foreign currency
     - **3.3.2.** The risk of inflation
     - **3.3.3.** The risk of interest rate
4. **EXTERNAL RISKS**
   - **4.1. Political risks**
     - **4.1.1.** The risk of election and changing the government
     - **4.1.2.** The risk of governmentfailure
     - **4.1.3.** Transnational political risk
   - **4.2. Force majeure risks**
     - **4.2.1.** The risk of natural disaster
     - **4.2.2.** The risk of terrorism
     - **4.2.3.** The risk of military conflict
   - **4.3. Other external risks**
     - **4.3.1.** Tax risk of general character
     - **4.3.2.** Tax risk of specific character
     - **4.3.3.** The risk of additional concessions
     - **4.3.4.** The risk of situation in the sector
5. **OPERATIONAL RISKS**
   - **5.1. Risks associated with equipment**
     - **5.1.1.** The risk of inputs (material)
     - **5.1.2.** The risk of maintenance, repair, modifications and adaptation
     - **5.1.3.** The risk of low residual value
   - **5.2. Risks associated with manpower**
     - **5.2.1.** The risk of non adequate manpower / the risk of irreplaceability
     - **5.2.2.** The risk of lack of manpower
     - **5.2.3.** The risk of labor disputes
     - **5.2.4.** The risk of human error
   - **5.3. Security risks**
     - **5.3.1.** The risk of fraud or illegal dealings
     - **5.3.2.** The risk of technological system´s safety
     - **5.3.3.** The risk of damage or theft
6. **STRATEGIC RISKS**
   - **6.1. Contractual risks**
     - **6.1.1.** The risk of liability to third parties
     - **6.1.2.** The risk of changes in the contract
     - **6.1.3.** The risk of breaking the generally binding regulations
   - **6.2. Other stategic risks**
     - **6.2.1.** The risk of strategic decision
     - **6.2.2.** The risk of reputation[5]

### *2.1 Construction, technological and project risks*

These risks are directly related to the characteristics of the building, its construction and project preparation, construction works, implementation and operation of the

infrastructure. As for transport, there is a set of international rules to clearly identify the scope of accountability, responsibility and risk sharing for each counterparty. In transport it´s called INCOTERMS and in building sector exist so-called FIDIC books for similar purposes as INCOTERMS.

However, road infrastructure projects are specific in that, it is impossible to itemize all the risks definitively to each counterparty. Problem is, that we can estimate the composition of the bedrock, rock or hill, where we want to build the road infrastructure but the actual conditions may be quite different.

### *2.2 Credit risks*

Their nature is based on the fact that one of the counterparty breaks or fails in fulfilling the conrtract conditions. Consequences are increased cost or project delay.

### *2.3 Market risks*

Formation and rate of these risks are affected by macroeconomic indicators but they may also occur because of the low rate of demand for public services.

### *2.4 External risks*

They are not the result of fault by one ofthe actors of the project but arise from influence of external factors and external environment of the project. Their management is problematic. These risks can have business and financial impact on both. On private sector and also on public sector.

### *2.5 Operational risks*

Operational risks are directly related to execution of works on the project and organization of human resources.

### *2.6 Strategic risks*

Strategic risks are those risks that have a relation with intention of the company and the results of correct or incorrect decisions may have serious consequences for the future of the company.

## 3 Proposals of various methods for elimination these risks

There are a few proposals of various methods how these risks can be eliminated and how construction of the road infrastructure can become safer.

### *3.1 The double-envelope system for evaluating the tenderers*

One of the possible improvements in decision making process could be for example The double-envelope system for evaluating the tenderers. It´s based on separation the offered quotation from technical solution. In this system each tenderer delivers 2 envelopes. The first contains anonymous technical solution of the building and the second the quotation for this technical solution.

The first phase is about opening the envelopes with technical solutions, scoring of tenderers in each evaluation criteria and then determining the weight of each criteria by independent expert jury. This way the most appropiate technical solutions are chosen. Tenderers whose technical solutions do not achieved the minimum qualifying criteria are eliminated in the first round of the tender.

In the second round the envelopes with quotations are opened publicly and they are evaluated by similar scoring system as technical solutions in the first round. Finally there are assigned weights to points for the price and for quality. Price mustn´t get bigger weight than quality. Company with highest rating wins.

Critical point in this process is proper determination of weights in each category for quality and price but the result is professional and impartial evaluation of the technical solution even in a country with higher index of corruption.

### *3.2 Elimination of construction, technological and project risks*

Pre-project and project preparation is the basis of whole construction process. High quality project preparation can eliminate a lot of construction risks. That is why is so important to have enough financial resources ready for reliable companies which guarantee quality terrain maping, project of good quality, preparation of researches, technical documentations, site preparation, budgeting and building. With these activities the company prepares documents about project realisation which warn realisation teams against various dangers. Project must be designed properly for the first time because re-making or making new project requires a lot of additional funds and takes a lot of time.

Regular collection and disposal of construction and dangerous waste are important for elimination the risk of contamination the environment around the construction site.

Very important is also choosing the right technology in order to its performance and benefits meet the requirements on the section where the technology is going to be used. That eliminates the risk from over or under-sizing the technology.

### *3.3 Elimination of credit risks*

Credit risks associated with the construction contractor can be partially eliminated in the tender where all tenderers solvency is examined. Companies that aren´t solvent are discarded and the tender continues only with companies which are not supposed to become insolvent.

The risk of fail to fulfill obligations can´t be eliminated but in contract can be mentioned consequences which one of the counterparty abide in case of default.

Elimination of the risk of concentration is very simple and it´s based on cooperating with more than just one supplier. So if one of the suppliers fails, we can cooperate with another immediately.

### *3.4 Elimination of market risks*

An important thing after the road opening is the correct setting of charges for its use and adequate complementary services (gas stations, quality parkings and rest areas, SOS phones, etc.) which will increase interest in its use. Disproportionately high charges and poor services could discourage motorists from using this road which would cause reduction of demand and low income.

The foreign currency risk can be partially eliminated by choosing the most stable currency in which counterparties will trade.

The risk of interest rate can be quite successfully eliminated by stipulation of the fixed interest rate throughout the repayment period.

### *3.5 Elimination of external risks*

These risks are also known as “vis major”. That means on their formation is not participating none of the counterparties and are difficult to eliminate them. It´s necessary to have prepared emergency plans if there would be a fulfillment of one of them and it´s necessary to behave according to these plans. For example it is evacuation in case of fire, flood or another natural disasters.

### *3.6 Elimination of operational risks*

Because this category is mainly about risks occurring and related with work on the construction site very important is responsible recruitment of competent subcontractors who meet all the prerequisites for responsible supplying materials or services in required quality.

Contractor´s responsibility is to ensure the proper functioning of the technology on the construction site. That can be ensured by regular controls and maintenance which eliminate the risk of technology breakdown or accident. Technology breakdown could cause serious material damages, injuries, financial losses or time delay.

The risk of non adequate manpower, the risk of irreplaceability or the risk of human error are closely interrelated and their elimination shouldn´t be taken lightly. Many of the tragedies on Slovak D1 highway happened just because there wasn´t present competent construction supervisor who could stop works performed in unsuitable conditions.

The main tool of these risks elimination could be strict control, which would not allow performing some works in case of absence of the person competent to do that work or absence the competent supervisor. Important thing is also to have more competent people to perform one work and if any of them are indisposed do not replace him by untrained worker. This kind of replacing is a sign of lack of manpower. In this case are all risks focused on a small group of workers who are entrusted with plenty of challenges and this leads to human error.

The easiest way how to eliminate the risk of damage or theft is hiring a private security service which will protect the workers, materials and technology against attack, damage or theft. It can also does a random checks among the workers on the construction site to check if they are not involved in any illegal activity or if they aren´t under the influence of alcohol.

### *3.7 Elimination of strategic risks*

The strategic risks include for example the risk of changes in the contract. Both counterparties lawyers care about elimination of this risk and it starts already in the initial contract negotiations.

Strategic decision has often strong impact on the future of the company and that is why are all strategic decisions considered carefully. Final decision is chosen after considering all possible options.

Every contract which company accepts as well as its public appearance have strong impact on its reputation. The only option to eliminate the risk of bad reputation is building a reputation based on probity, reliability, responsibility and quality work, good public appearance and customer service.

## 4 Accidents during the construction of Slovak D1 highway

Slovak D1 highway is still under construction but many serious accident have already happened. All of them are results of wrong organisation on the construction site or low quality of delivered materials or services. A few of the biggest accidets are subscribed here.

### *4.1 Collapse of the bridge construction near Kurimany*

In 2012 collapsed the bridge construction near Kurimany and 4 workers died. As the investigation has shown there were 2 reasons which collaborated on forming of this situation. An effort to save money by using less props and incompetent construction supervisor who authorized the works even when there were less props. Construction supervisor authorized the concrete pouring although there were used less props than was originally planned. The maximum length of the props below the pouring point increased from 4,7 m to 18,4 m which caused that the strenght of the construction decreased 15,3 times. Therefore the construction collapsed after pouring 330 cubic meters of concrete of total 500 cubic meters.

*Figure 3 Collapse of the bridge construction near Kurimany in 2012 [6]*
***Author:*** *TASR*

### *4.2 The fall of 4 workers near Martin*

In 2013 near Martin 4 workers fell from bridge construction during 6 months. Rudolf Kubica, chief labor inspector of the Labour inspectorate in Žilina, commented the situation on the construction site: " The main function, the coordinator of safety and health at work, isn´t working here very well. Contractor has to appoint this coordinator, and this coordinator then coordinate each subcontractors. There should be a health and safety plan. But we find out, that the subcontractors, who perform works on the construction site, have no project documentation, so they do not even know what and how can they actually do."

*Figure 4 The fall of 4 workers during 6 months near Martin [7]*
***Author:*** *SITA, Ľudovít Vaniher*

### *4.3 Explosion in Šibeník tunnel*

Big tragedy happened in The Šibeník tunnel in august of 2013. Shotfirer was killed when he went to check the explosion which several times failed to explode. When he was handling the explosive it exploded and rocks swamped the shotfirer. The first results of investigation said that was a human error, but the right cause may extend to higher circles and it seems to have failed the entire work organisation. According to shotfirer´s family the subcontractors force the workers to work several shifts in a row without free days and they´re breaking a law with that.

*Figure 5 Exploison in Šibeník tunnel [8]*
***Author:*** *SITA, Radoslav Maa*

### *4.4 Alternative routing of Turany - Hubová section*

This problem is here since the idea of connecting Košice and Bratislava with highway was born. There are 3 options of routing this section. The north variant, The south variant and The valley variant. Many of EIA and engineering researches were been made and the best options according to this researches are The north or The south variant because the route would be shorter, the construction and using the road would cause lower impact on the environment and The south variant gives assumptions to improve the railway inrastructure and built a railway corridor in same tunnel with the highway.

But the government wants to realize this section via The valley variant even if there are many negatives. The valley variant crosses 6 protected nature areas, the route is longer, its planned across the area where is high risk of landslides, in winter there is lack of sunlight so there would be high risk of icy on the road etc.

The final option is still not chosen which means the opening of the highway is still in very distant future.

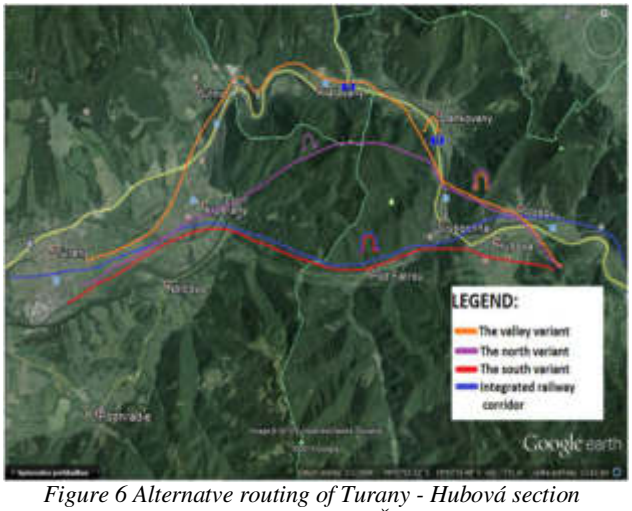



*Figure 6 Alternatve routing of Turany - Hubová section*
***Author:*** *Dávid Šimko*

## Conclusion

As we can see these risks and their consequences are very actual problem. Here in Slovakia is the highway construction too politicizated. Every new government after election thniks that the past government did everything wrong so everything must be stoped, re-projected, re-calculated and must be done according to new government. This cost a lot of funds and time, because eveyrthing have to be started from the bottom.

It is also because when the governments change, people who made decisions about the construction, had connections and stakes in companies that were connected with construction changes too. They are replaced by people from new government who wants to earn money too.

In this times of financial crisis, when states do not have money on unnecessary expenses is the main criterion for making decisison often the price. The combination of lack of state fundings and desire of some people to become multimilionaire often cause poor quality of work, poor quality of used materials, accidents or deaths and often also additional funds to repair the damages.

## References

[1] ŠIMÁK, Ladislav: Manažment rizík, University of Žilina, Faculty of special engineering, Žilina, 2006.
[2] Wikipedia – Free encyklopedy [online]. [quated 10-01-2014]. Available on: <http.//www.wikipedia.org/>.
[3] Krízový manažment [online]. [quated 10-01-2014] Available on: http://www.km.weblaho.sk/.
[4] Slovak road administration. [online]. [quated 14-03-2013]. Available on: http://www.ssc.sk/.
[5] Internal documents of PPP centre.
[6] ŽGRAVČÁKOVÁ, Eva: Diaľničné tragédie smerujú na prokuratúru [online]. Pravda. [updated 20-09-2013]. [quated 13-02-2014]. Available on: <http://spravy.pravda.sk/ekonomika/clanok/293596-dialnicne-tragedie-smeruju-na-prokuraturu/>.
[7] Webnoviny.sk: Prekliaty úsek D1, robotník spadol z osemmetrovej výšky. Webnoviny. [updated 16-01-2014]. [quated 13-02-2014]. Available on: < http://www.webnoviny.sk/slovensko/clanok/778856-prekliaty-usek-d1-robotnik-spadol-z-osemmetrovej-vysky/>.
[8] ŽGRAVČÁKOVÁ, Eva: Výbuch v tuneli čoskoro objasnia [online]. Pravda. [updated 02-02-2014]. [quated 13-02-2014]. Available on: <http://spravy.pravda.sk/ekonomika/clanok/307197-vybuch-v-tuneli-coskoro-objasnia//>.

**Review process**
Single-blind peer reviewed process by two reviewers.

# PROGRAMMING OF METHODS FOR THE NEEDS OF LOGISTICS DISTRIBUTION SOLVING PROBLEMS

**Andrea Štangová**
TU of Košice, Faculty BERG, Logistics Institute of Industry and Transport, Park Komenského 14, 043 84 Košice, Slovakia, andrea.stangova@gmail.com

***Keywords:***distribution logistics, multicriteria evaluation, allocation, mathematical and geometrical methods, ELODIS program
***Abstract:*** Logistics has become one of the dominant factors which is affecting the successful management, competitiveness and mentality of the global economy. Distribution logistics materializes the connesciton of production and consumer marke. It uses different methodology and methods of multicriterial evaluation and allocation. This thesis adresses the problem of the costs of securing the distribution of product. It was therefore relevant to design a software product thet would be helpful in solvin the problems related to distribution logistics. Elodis – electronic distribution logistics program was designed on the basis of theoretical analysis of the issue of distribution logistics and on the analysis of the software products market. The program uses a multicriterial evaluation methods to deremine the appropriate type and mathematical and geometrical method to determine an appropriate allocation of the distribution center, warehouse and company.

## 1 Introduction

Placement of production process, after identifying the product we´re going to produce and the way we´re going to produce it, is one of the main strategic decisions which we make in case of establishing a new production or company and in a case we´re trying to take control of new markets, invest and increase production capacity [1].

Allocation brings a problem which is connected with high expenses for providing distribution of products. Therefore it was advisable to build a software product which will be helpful with creating and solving problems connected with distribution logistics. Also elaborateness of multi-criteria evaluation and allocation predestine to solve distribution with the help of computer techniques.

### *1.1 Allocation*

Suitable placement of company influences all the activities which distribution includes. We take into consideration many factors which are important within allocation. Two approaches were created and they serve for calculation of a correct allocation:[2]

- Multi-criteria decision-making
- Mathematical and geometric approach

*"The allocation is the process that results in a particular position to determine the location of the storage, company, machine, manufacture, people, animals, things and activities in a particular area, respectively area that best meet the defined conditions and limitations in terms of requirements, eg. supply, production, distribution and trade, strategies and tactics [2]."*

## 2 Analysis of software products

Today's time offers a wide range of different applications and software programs to calculate various examples, methods and solutions. Development of information systems is rising along with the exponential growth of information technology. Find high-quality free software is quite complex. For less demanding users, the company offers a variety of freely available software, which can be very useful for them. In case the user wants more features and more options should you pay extra for the licensed version, which offers a wide range of user interface.

Area of professional products for decision-making provides some softwares or web applications which are orientated on methods of multi-criteria decision-making, e.g. [3]:

- Programme MCA7
- Expert Choice
- Criterium Desicion Plus
- 1000 Minds
- IDS
- DEXi 4.00
- Priority Estimation Tool
- D- Sight
- Transparent Choice

Analysis of professional products for multi-criteria decision-making demonstrated us that nowadays many products like this exists and provide solutions to the professional level. Simpler programmes mostly contain only one method and the way of calculation. Complexity of other programmes discourage the users from their application. Therefore it was suitable to create a software

product which would combine a bigger amount of methods and with its simplicity make work of users easier and simultaneously providing professional solutions for the needs of practice.

## 3 Programme ELODIS

Programme ELODIS – „Electronic Logistics of DIStribution“ (Figure 1) solves problems of multi-criteria decision-making and allocation which have strategic importance for a company. Overall effectiveness of particular criteria and overall effectiveness of particular variants is calculated by methods of multi-criteria decision-making. Mathematical and geometric methods help with calculations for a suitable allocation of distribution centre, storage, company, etc


*Figure 1 Programme ELODIS, main window*

### *3.1 Charakterization of programme ELODIS*

Programme ELODIS is written in its developmental environment Microsoft Visual Studio 2010, in programming language C++. It´s a universal, simple programme made for complex processing of multi-criteria evaluation and allocation.

Within multi-criteria evaluation, the programme offers a method of score multiplication, weighted sum method and methods of quadratic graph (Figure 2).

The more complicated methods like method of paired comparison and Saaty´s method are created to be as easy for user as possible (Figure 3).

Within allocation, it offers mathematical and geometrical methods like method of allocation with axial distance (Figure 4), allocation with quadratic distance and at the end also Cooper´s iterative method.

#### 3.1.1 Allocation and multi – criteria desicion making

If companies want to be competitive, it is necessary for them to try to minimalize expenses what is the reason of distribution logistics and well-placed storage becoming an important and essential part of company functioning. Decision about place of storage allocation and necessity of building it has a strategical importance. Method of multi-criteria decision-making serves as a helping tool for distribution logistics with making this important decision. We use the multi-criteria decision mainly in a situation when we can economically assess the factors which influence the allocation of production process, storage or centre [2].

*Figure 2 Filling of the ELODIS table*

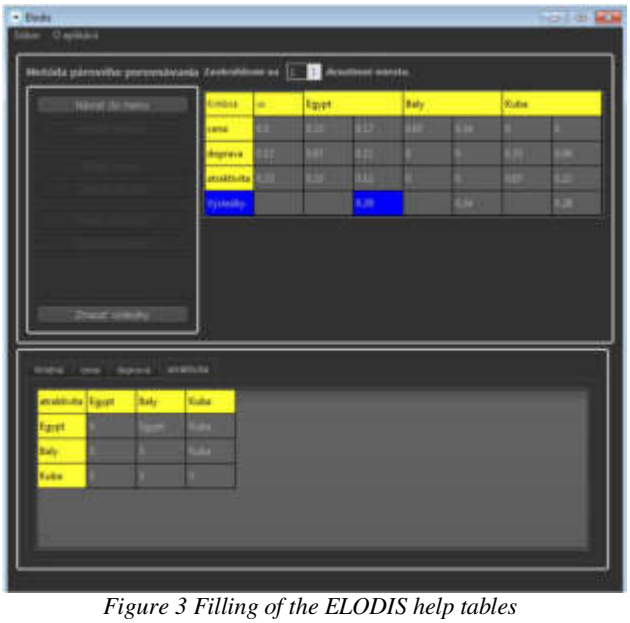


*Figure 3 Filling of the ELODIS help tables*

Indirect methods of multi-criteria assessments are based on mutual comparison of all defined criteria and variations between them. Methods are more complex and have a lesser degree of subjectivity.

Comparing the methods paired comparison and Saaty´s method we came out that the results are not the same. It is caused by different computing technology of these methods. For paired comparison determine which of the criteria / variants is important. Whereas for Saaty´s method we determine which of the criteria / variants are important, but also the number of times they are more important. Using both methods reduces subjectivity user / evaluator. To ensure even lesser extent personality is possible to use a larger number of evaluators.

### 3.1.2 Allocation and mathematical and geometrical methods

Mathematical and geometrical methods solve problems of optimal placement of distribution centre, storage, company, operational report or a machine and an accurate determination of coordinates in a defined area. It uses a cost criterion during calculation with the aim to minimalize expenses [2].

Allocation and mathematical - geometric methods are based on the calculation of the coordinates operational reports, distribution warehouse centers and subsequent cost reductions, which are used in the evaluation.

Comparing the practices of three methods we figured out that the results are similar but not the same. It is caused by different computing technology of these methods. When allocations with axial distance can only be the result of a combination of points already defined in the table. When allocations with quadratic distance improves the precision of the calculation and the calculated points can be used in the Cooper´s method. Cooper's method, thanks iterations, guarantees the most calculating of these three methods for the allocation distribution storage.

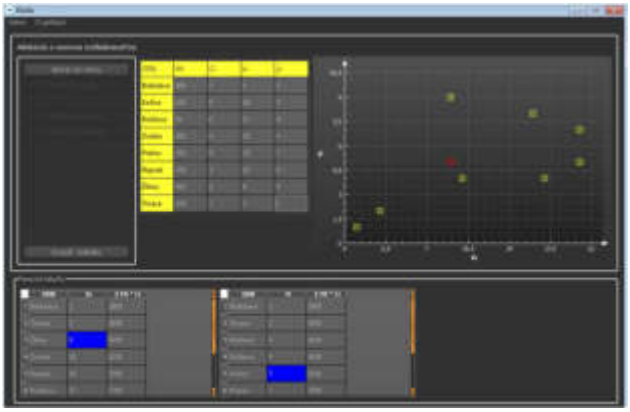


*Figure 4 Application of geometrical aproach for allocation*

## 3.2 *Advantages of programme ELODIS*

Programme ELODIS solves problems of multi-criteria decision-making and allocation which have a strategic importance for a company. It calculates the overall effectiveness of particular criteria and overall effectiveness of particular variants by methods of multi-criteria decision-making. Mathematical and geometrical methods help with calculation of suitable place for allocation of distribution centre, storage, company, etc. It is a universal, simple programme made with aim of complex processing of multi-criteria evaluation and allocation. ELODIS is a programme which contains 5 methods of multi-criteria decision-making and 3 mathematical and geometrical methods.

There is no similar software on the market which would combine all these methods. This makes programme ELODIS unique. Working with this programme is very simple and easily understandable for a user. Installation is clear and it´s completed in a few seconds. User has a possibility to compare particular results with more methods what decreases the rate of subjectivity.

Programme is very well-arranged and right after opening it offers an option to choose a method for solving a problem. The main advantage is the speed of calculation. If we tried to count all the examples without the programme, it would take us a few hours, if not longer. If user makes a mistake when filling in data, the programme warns him about mistakes.

The programme offers a well-arranged manual which helps the user to solve any problem.

It is possible to save entered data and also to export the results to Excel or print them. It is also possible to re-read a file.

This programme would be a miracle for decision-making in company. It would help to solve every-day problems with distribution, allocation and evaluation of problems. Decreasing of costs would help companies to save not small financial amounts.

## Conclusion

Logistics became a phenomenon of the 20$^{th}$ century which influences functioning, managing and thinking of people, organizations and world economy. Multi-criteria evaluation and allocation became an important part of management and running of company. Every decision in company is made according to multi-criteria evaluation. Allocation of production process is one of the main strategic decisions when establishing a new company, production and taking control of competitors. Uniting logistics and information technologies forms a new way for future orientation and development of logistics.

With all the results we came to an opinion that programme ELODIS could mean a huge contribution because it makes many operations easier, it decreases costs for distribution logistics and costs for similar software programme, it saves time and the programme is very complex.

**Acknowledgement**

Publication has been created with the support of VEGA grant agency, in the framework of grant task VEGA 1/0036/12 *„Methods development and new approaches to design of input, interoperable and output warehouses and their location in mining, metallurgy and building industries“*.

## References

[1] MALINDŽÁK, D. et al: Výrobná logistika I., Košice, Štroffek, 8-45, 1996.
[2] STRAKA, M.: Logistics of distribution, How effectively to put product into the market, EPOS, Bratislava, p. 400, 2013.
[3] RUIZ, F.: International Society on Multiple Criteria Decision Making, 2014.

**Review process**
Single-blind peer reviewed process by two reviewers.

# INFORMATION LOGISTICS AS MEANS OF INFORMATION SERVICES FOR FREIGHT TRANSPORT NEEDS

**Martin Straka**
TU of Košice, Faculty BERG, Logistics Institute of Industry and Transport, Park Komenského 14, 043 84 Košice, Slovakia, martin.straka@tuke.sk
**Peter Bindzár**
TU of Košice, Faculty BERG, Logistics Institute of Industry and Transport, Park Komenského 14, 043 84 Košice, Slovakia, peter.bindzar@tuke.sk
**Michal Balog**
TU of Košice, Faculty of Manufacturing Technologies, Department of Manufacturing Management, Bayerova 1, 080 01 Prešov, Slovakia, michal.balog@tuke.sk

***Keywords:*** information logistics, information system, parking, freight transport
***Abstract:*** European parking information center (EPIC) – it will provide unified and detailed information about European parking areas. The EPIC system will receive the data from local information centres. For Slovak republic there will be one provider for traffic data – a National traffic information center (NDIC). The EPIC system is available at http://truckinform.eu. Intelligent parking system (IPS) will be linked with NDIC. The aim of the IPS system is to provide information as follows: number of free parking places, services to be used in parking area and so one.

## 1 Introduction

To ensure effective functioning of the National traffic information system NSDI in Slovakia the following should be implemented in the future [1]:

- To engage all competent public authorities to the NSDI abreast of national, regional and local authorities,
- To build the NSDI as an open modular system integrating all available data from information systems of the operators who have built their own information systems (eg, communications managers - National Highway Company (NDS), the Slovak Road Administration (SSC), Police Force (Police Corps), Fire and Rescue Corps (HaZZ), the national center, regional centers, specialized centers of each individual service and information systems that will work on information and not control lines
- Providing of traffic data will be understood as a public service, i.e. traffic information will be available in basic form under appropriate conditions for free to anyone who will ensure their further spread, or use it for improving traffic and transport,
- To edit the Act No. 211/2000 Coll (Freedom of Information Act) for purposes of cooperation elements of the information system and information needs in terms of optimization of freight haulage.

## 2 Analysis of logistic chain in terms of information needs

When systemic processing of analysis from the perspective of logistics chain information needs, please be aware of the following characteristics:

- System consists of a limited number of elements,
- the logistics chain elements are in mutual correlation,
- elements of the logistics chain are in correlation with its environment.

For system analysis of logistics chain elements in term of information needs, the folloving is important:

- defining elements of the logistics chain,
- rigorous analysis of existing information flows,
- the exact formulation of the information relationship between suppliers, carriers and customers,
- analysis of the elements of the logistics chain in terms of information possibilities

### *2.1 Description of logistic chain*

Currently there is increasing pressure for improving the effectiveness of all activities, not only in the transport sector. Restructuring, modification of obsolete thinking and old habits and activities of form is closely associated with the use of information technology, modern approaches and modern logistics methods to increase efficiency, rationalization and optimization of material, financial and information flows. Management and implementation of flexible global logistics networks with their high demands of communication and coordination creates the preconditions for continued strong growth.

A specific term of logistics is the logistics chain. It is a set of elements, arranged to create flow of information and materials needed in terms of a specific aim. Logistics chain is the flow of products from the raw materials to end user. A typical logistics chain is shown in Figure 1.

According to the transport the logistics chain can be characterized by transport chain as a sequence of interconnected technical and organizational operations,

which were transporting people or goods from one source to the target. Transport chain may be a monomial or multi part. For multipart chain considering relationship manufacturer – consumer there is a change in transport means.

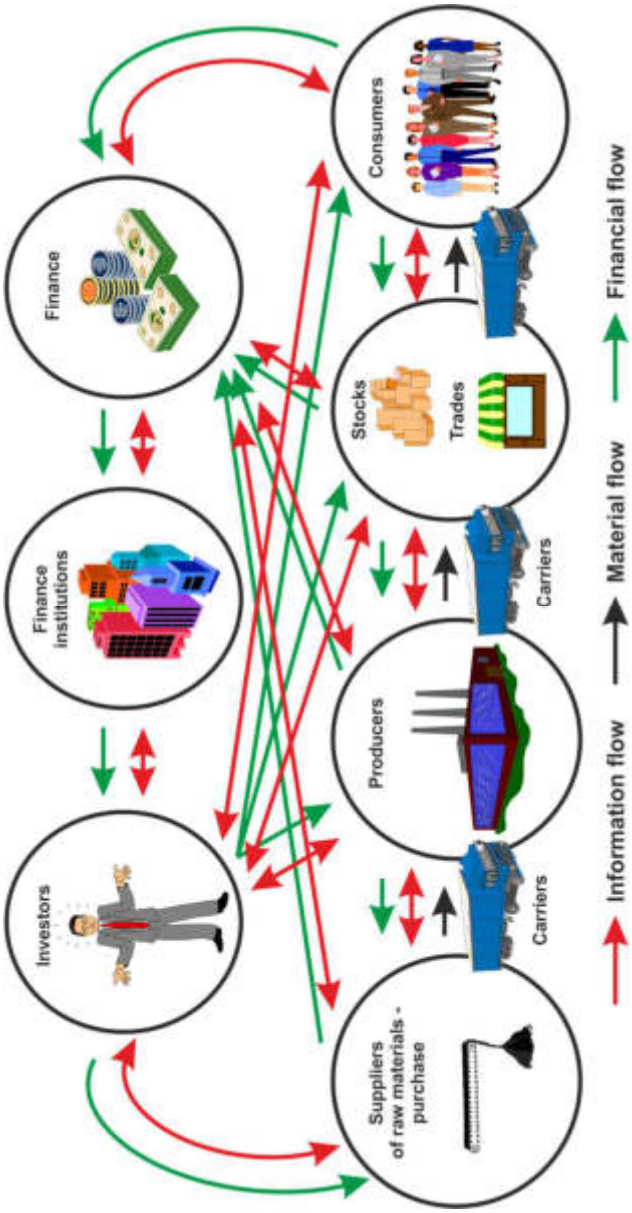



*Figure 1 Logistic chains*

Transport as shown in Figure 1, is one of the most important elements of the logistics chain. It participates as an intermediary between suppliers of raw materials and manufacturers and also between the manufacturers and warehouses, shops and consumers. The above picture shows the importance of transport national or international.

While organizing the technological process of transport, it is desirable to achieve the best indicators of the use of vehicles, in terms of performance, time and capacity. Next the transport has a major impact on growth and decreasing of logistics costs. While organizing the technological process of transport, it is desirable to achieve the best indicators of the use of vehicles, in terms of performance, time and capacity and has a major impact on traffic growth and decrease logistics costs. The aim of freight transport is to overcome distances, to transfer the goods from point of manufacture to point of consumption. The role of transport from logistics point of view is [1]:

- Choosing the most suitable means of transport - Transport means is concrete transport device for transportation. The choice means of transport mainly affects the length of path that goods must overcome, type, kind of goods and space in which the goods will move by means of transport. In normal practice, for delivery of goods within the republic the road transport is used. Normally, most commonly used transport means are trucks up to 3 tons. Vehicles over 3 ton of capacity weight is mainly used for transport to greater distances or to combine multiple items.
- Choosing the most suitable transport process - the transport process is associated with the organization and management during transport.

## *2.2 Description of logistics chain elements*

Figure 1 shows a typical logistics chain with highlighting of information, material and financial flows. Its elements are as follows:

- Suppliers of raw materials - there are mainly mining companies who provide transportation of raw materials within their own capacity or by external carriers. For case above the road freight transportation is used only for short distances, or for collection of goods to the nearest transfer station. Therefore it is not necessary for suppliers to think about parking [2].
- Carriers - are companies designed to transport goods and products between suppliers and producers and between producers and final consumers or distributors, warehouses and so on. As shown in Figure 1, the carriers in the logistics chain are represented many times. Developing a smart parking system is especially useful for transport companies that will be able to make better and more effective transportation routes. In addition, working conditions for truck drivers will be improved.

Manufacturers - many manufacturers will provide transportation of their products within its own fleet. For these manufacturers, it is very important to take the issue of planning and optimizing routes and tracking of goods being shipped.

The second group of manufacturers that manufacture only their products are seeking ways of reducing their costs for transport, handling and storage. Therefore, all activities related to the goods shipment moves to a specialist - the carrier, which assigns the following activities, including distribution to the final consumer. In this case, planning and optimizing routes are carried out directly by shipping company.

Stores and shops - acts as an intermediary between producers and consumers. Like the producers the stores, shops and distributors often need to think about the issue of transport planning. In particular, distributors are an element of the logistics chain who are mostly under pressure in order to ensure quality of logistics services (supply timely, optimization of costs and traffic routes, security). Safety breaks of truck drivers should be also considered in step with the existing legislation of the SR and the EU.

Consumers - acts as end customers, who are not in the important from IPS data providing point of view.

When building intelligent parking system it should be considered with other elements in the logistics chain, such as:

Authorities - acts as responsible for legislation and implementation of laws. Define using of lands and roads.

Road Manager - The public authority responsible for the construction, operation and maintenance of road networks.

Road operator - is a private company having license for construction, operation and maintenance of road networks.

The provider of parking - builds, operates and maintains parking lots. The provider of parking can be public or private organization with a different range of activities.

Parking Operator is only provider of parking responsible for the operation of the parking lot. It can be public or private institution.

### *2.3 Analysis of logistic chain elements*

The most important element in the logistics chain from the perspective of the needs and providing information is the carrier, so that next an analysis is focused primarily on quantity and quality of the information that the every element can provide or requires. Whenever, basic logistical chain begins with the client, which may be in the form of input raw materials supplier, manufacturer or distributor and ends at the end user, who may be in the form of stores, shops, manufacturers and consumers. It is obvious that some elements of the logistics chain can be both the provider and recipient of information [1].

The current situation is characterized by non-systemic providing of information about parking possibilities. The most common information provided on parking areas is as the following:

- the location, direction,
- telephone contact,
- capacity,
- parking facilities,
- the availability for the dangerous goods or special cargo.

A traffic data for truck drivers can be provided by following ways:

- brochures and maps,
- internet portals,
- mobile devices,
- public information resources,
- variable traffic signs,
- verbally between the truck drivers.

For shipping company the goods transportation is realized by two ending elements that are acivelly participating on transport process:

- truck driver,
- transport operator in transport company.

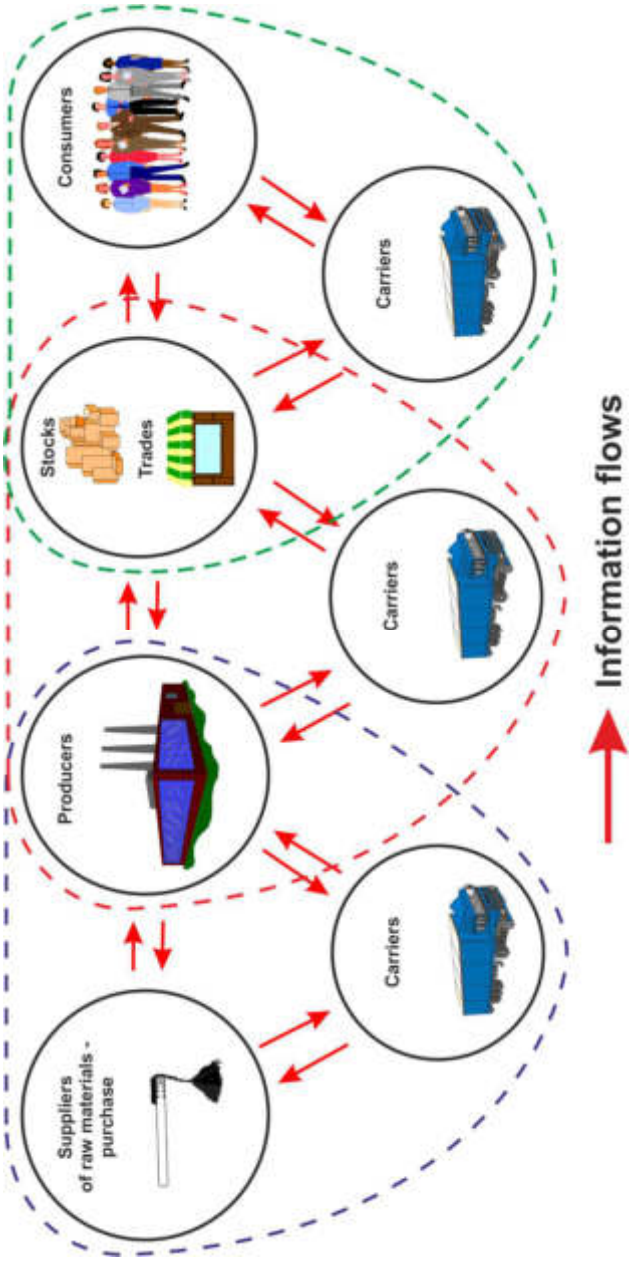



*Figure 2 Information triads [2]*

The scope for a systemic analysis of information needs for the elements of logistics chain is Figure 1. Figure 1 shows the flow of information between shipping companies on the one side or suppliers and buyers on the

other. In this context it should be noted that some elements of logistics chain may also act as a recipient as well as suppliers. For example, the manufacturer acts as a recipient if buying from the supplier of raw materials or as a supplier if sending its products to warehouses, shops or distributors.

It is obvious that manufacturer's information needs will vary in nature, in terms of quality and type of data to be provided or received on input and output.

The level of analysis of information flows across the logistic chain is focused on solving a basic level of information flow that is level between manufacturers, carriers and consumers [1], [3]. This level in terms of information flow is characterized by a triangular relation - logistic triads. There are following groups of information relationships:

1. Group A – consists from supplier of raw material – carrier – manufacturer.
2. Group B – consists from manufacturer – carrier – warehouses / stores / distributors.
3. Group C – consists from warehouses / stores / distributors - carrier - consumers.

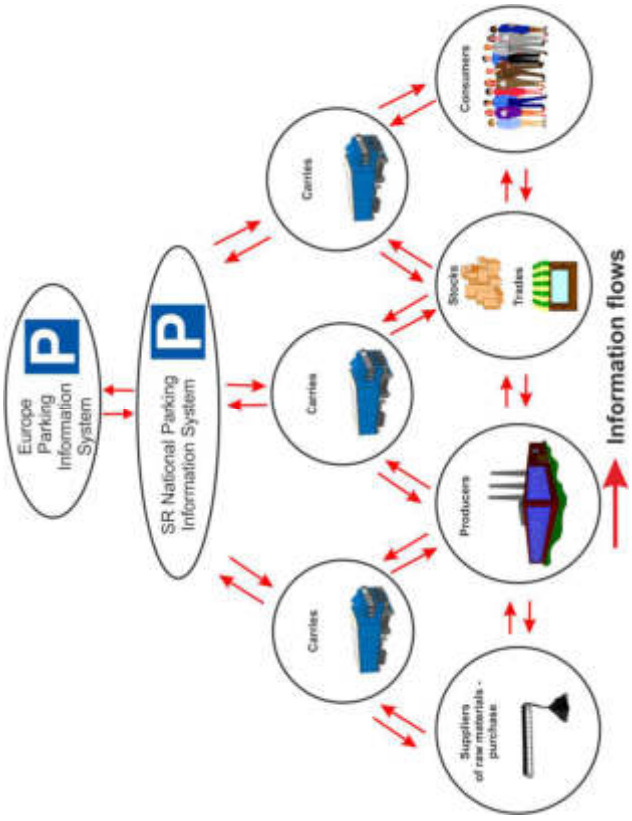



*Figure 3 Logistic pyramides of information flows [1]*

The relationships between any elements create 2 levels (Figure 2). The first one consist from suppliers of raw material, manufacturers, distributors, stores and consumers [1], [2], [4]. The next level consist from carriers. The above mentioned levels can be extended about other 2 levels representing the National Intelligent Parking System (IPS) and the European Transport Parking System (EPIC) (see Figure 3).

With the introduction of intelligent parking it would be useful if parking areas were in accordance with system of Intelligent Transport Systems ITS. or specifically with NDIS system in our country. The IDS system is able to manage increasingly difficult traffic situation on the road [1], [5]. Interconnection of IDS information system with information system of Intelligent parking system (IPS) will be solved later.

Possible architecture of information flows between national IPS system and European transport parking system EPIC is shown in Figure 4.

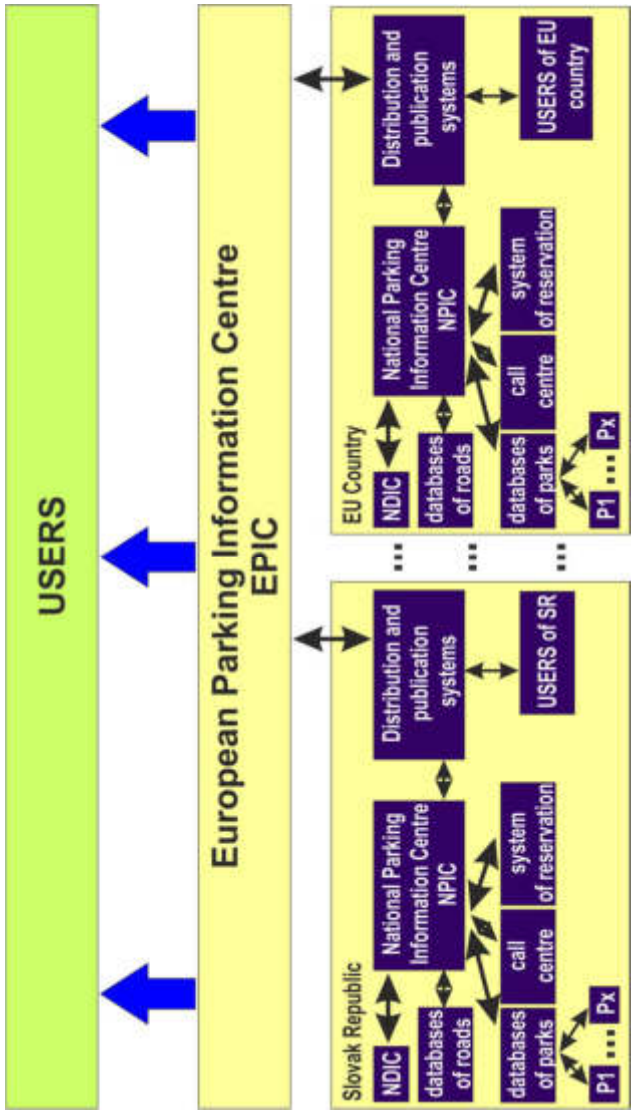



*Figure 4 Possible architecture of information center NPIC and EPIC with its elements and its mutual cooperation [1]*

European parking information center (EPIC) – it will provide unified and detailed information about European parking areas. The EPIC system will receive the data from

local information centres. For Slovak republic there will be one provider for traffic data – a National traffic information center (NDIC). The EPIC system is available at http://truckinform.eu

The EPIC system will include an interactive map of the EU so that every user enters the desired area / state by clicking on the map. The user can access to multilingual information about the location, parking lots, services provided by different parking operators, etc. The basic language is recommended to English.

National Parking Information Center (NPIC) is going to be linked with road database and National Transport Information Center. The aim of the NPIC is to provide data about free parking lots, services in every parking area, etc. The part of NPIC system will be a database of parking areas, call centrer and reservation system.

The reservation system - used to reserve space on the parking area.

Call Center - provides information about individual parking areas, next solves problems of drivers, performs bookings by phone. It is recommended to communicate in Slovak and English language.

Distribution and publication channels – are used to distribute all the information to road users like truck drivers.

Data distribution interface can be divided into 2 groups:

- information that are provided before driving like internet, television,
- information that are provided during driving like radio broadcast, RDS-TMC, variable road signs

Database of parking places - store information about parking facitities and services as well as some contacts. Examples for parking services are as the follows:

- A petrol station,
- Roadworthiness tests of vehicles,
- Possibility of weighing of loads, restaurant,
- connection to the Internet,
- parking with security features,
- shower,
- toilets,
- possibility of parking for trucks with dangerous goods,
- possibility of parking for trucks with refrigerator,
- booking.

Parking areas wit its information system – the parking areas have information connection with parking database [1], [6]. A parking worker is responsible for updating a data about parking area.

### *2.4 Description of information triads*

The first communication link (Group A) is between supplier of raw material, carrier and manufacturer. The supplier of raw material and manufacturer communicate each other about:

- number of deliveries (before you go) - tons, pieces, ...
- quality of delivery (before you go) - the quality of raw materials,
- date of dispatch (before you go) - the time when the product is ready for shipment,
- the kind of goods (before you go) - the specific characteristics of materials,
- the price of raw materials (before you go) - contracted price of raw material,
- place of delivery (before you go) - delivery address,
- information about the customer (before you go). - billing Information.

Next the supplier of raw material communicates with carrier about:

- number of deliveries (before you go) - tons, pieces, containers, pallets, ...
- quality of delivery (before you go) - transport conditions,
- date of delivery (before you go) – a date of delivery to recipient,
- the kind of goods (before you go) - the specific characteristics of materials to be transported,
- price of deliveries (before you go), - the price for transport,
- place of delivery (before you go and during delivering) - delivery address,
- information about the recipient (before you go), - company name, contact person, phone number to recipient,
- type of transport (before you go) – the choice of means of transport.

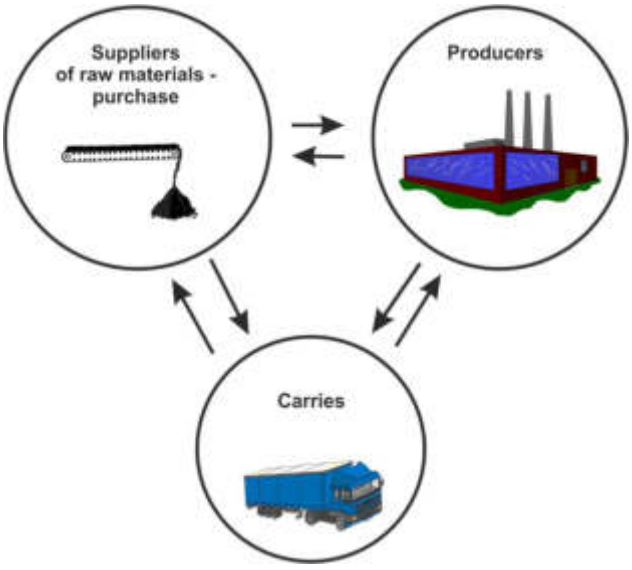



*Figure 5 Information flows in Group A [1], [2]*

Next there is a communication between carrier and manufacturer:

- date and time of delivery (before you go and during delivering),
- occurencce of unforeseen situations (during delivering). – accidents, traffic congestions
- contact data to recipient,
- delivery conditions or its modification respectivelly

Besides the above-described data, the carrier requires some other information that cannot be obtained from a supplier or recipient (manufacturer in that case). These data is as follows: carriageability, the possibility of rest, auto-service, etc. [1], [7], [8].

The second communication link (Group B) is between manufacturer, distributors / warehouses / stores and carrier. Manufacturers and distributors / warehouses / stores can communicate each other about:

- number of deliveries (before you go) - tons, pieces, ...
- quality of delivery (before you go) - the quality of producsts,
- date of dispatch (before you go) - the time when the product is ready for shipment,
- the kind of goods (before you go) - the specific characteristics of materials,
- the price of product (before you go) - contracted price of products,
- place of delivery (before you go) - delivery address,
- information about the customer (before you go). - billing Information.

Next manufacturer communicate with carrier about:

- number of deliveries (before you go) - tons, pieces, containers, pallets, ...
- quality of delivery (before you go) - transport conditions,
- date of delivery (before you go) – a date of delivery to recipient,
- the kind of goods (before you go) - the specific characteristics of materials to be transported,
- price of deliveries (before you go), - the price for transport,
- place of delivery (before you go and during delivering) - delivery address,
- information about the recipient (before you go), - company name, contact person, phone number to recipient,
- type of transport (before you go) – the choice of means of transport.

Next, there is a communication between carrier and distributors/warehouses/stores about:

- date and time of delivery (before you go and during delivering),
- occurencce of unforeseen situations (during delivering). – accidents, traffic congestions
- contact data to recipient,
- delivery conditions or its modification respectivelly

Similar to group A, the carrier requires some other information that cannot be obtained from a supplier or recipient (distributors/warehouses/stores in that case). These data is as follows: carriageability, the possibility of rest, auto-service, etc.

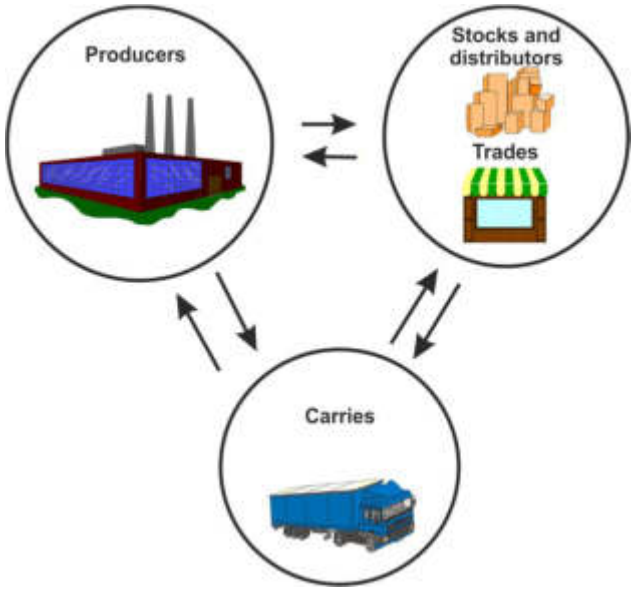



*Figure 6 Information flows in Group B [1], [2]*

The last group consist of distributors / warehouses / stores, carrier and consumers (Group C). There is a communication between distributors/warehouses/stores and customers about:

- number of deliveries (before you go) - tons, pieces, ...
- quality of delivery (before you go) - the quality of products,
- date of dispatch (before you go) - the time when the product is ready for shipment,
- the kind of goods (before you go) - the specific characteristics of products,
- the price of product (before you go) - contracted of fixed price for product,
- place of delivery (before you go) - delivery address,
- information about the customer (before you go). - billing Information.

Next the carrier communacate with distributors / warehouses / stores about:

- number of deliveries (before you go) - pieces, pallets, ...
- quality of delivery (before you go) - transport conditions,
- date of delivery (before you go) – a date of delivery to recipient,
- the kind of goods (before you go) - the specific characteristics of materials to be transported,
- price of deliveries (before you go), - the price for transport,
- place of delivery (before you go and during delivering) - delivery address,
- information about the recipient (before you go), - company name, contact person, phone number to recipient,
- type of transport (before you go) – the choice of means of transport.

Next, there is a communication between carrier and consumers about:

- date and time of delivery (before you go and during delivering),
- occurencce of unforeseen situations (during delivering). – accidents, traffic congestions,
- contact data to recipient,
- delivery conditions or its modification respectivelly.

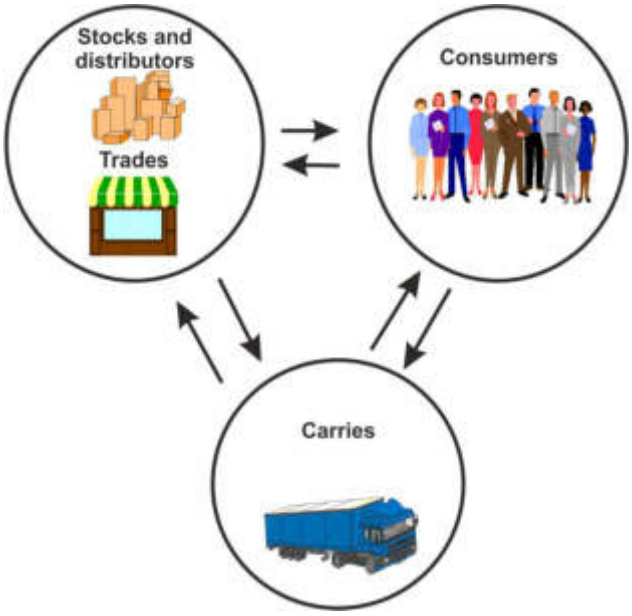



*Figure 7 Information flows in Group C [1], [2]*

Similar to group A and B, the carrier requires some other information that cannot be obtained from a supplier or recipient (customer in that case). These data is as follows: carriageability, the possibility of rest, auto-service, etc.

## Conclusion

It is possible to classify the data according to the information needs as follows:

- Information necesary for preparing a transport process.
- Information necessary to make transport.

The above-described information flows are important for the preparation of the transport process. They are not suitable for transport realization. The driver, as a road user has the information about carriageability or traffic-carrying capacity of some roads. The information are applicable when optimizing transport routes.

From systemic analysis of logistic chain it should be stated that for a safe and secure goods transportation it is important for driver to get correct information before and during deliveries. These information are for example: parking possibilities, location of parking areas, phone contact to parking operator, free parking lots in any time, parking facilities and services. In case of dangerous goods the driver also needs information if parking area can accept that kind of goods.

Besides the above mentioned data, the driver needs some traffic information such as weather conditions, carriageability and occurencce of unexpected colisions, data about possibility to go around.

**Acknowledgement**

Publication has been created with the support of VEGA grant agency, in the framework of *the grant task VEGA 1/0036/12 „Methods development and new approaches to design of input, interoperable and output warehouses and their location in mining, metallurgy and building industries“*, and framework of *the grant task VEGA 1/0216/2013 „Methods and new approaches study to measurement, evaluation and diagnostic performance of business processes in the context of logistics management company“*.

## References

[1] Straka, M., Balog, M. and Bindzár, P.: Project EASYWAY, Information services for users of logistics chain of heavy roads transport, Žilina, Research institute of transport, p. 53, 2010. (original in Slovak).

[2] Balog, M. and Straka, M.: Logistics information systems, Bratislava, Ing. Miroslav Mracko, EPOS, p. 208, 2005. (original in Slovak).

[3] Rosová, A.: Logistics costs of the enterprise, Acta Montanistica Slovaca, 12 (2), p. 121-127, 2007.

[4] Besta, P., Samolejová, A., Janovská, K., Lampa, M., Lenort, R.: Evaluation of benefits resulting from innovation of input raw materials dosing process in sintering, Metalurgija, 51 (4), p. 457-460, 2012.

[5] Witkowski, K., Saniuk, S.: Aspect of logistics management of the city infrastructure, Logistyka 41 (2), p. 589-600, 2011.

[6] Winkler, R.: Effectiveness - an attempt about conceptualization of the idea, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie, No. 820, Cracow, p. 105-117, 2010.
[7] Trebuňa, P., Halčinová, J.: Mathematical Tools of Cluster Analysis, Applied Mathematics, 4 (5), p. 814-816, 2013.
[8] Cagáňová, D., Čambál, M., Weidlichová Luptáková, S.: Intercultural Management – Trend of Contemporary Globalized World, Electronics and Electrical Engineering, Technologija, Kaunas, 6 (102), p. 51-54, 2010.

**Review process**
Single-blind peer reviewed process by two reviewers.

Acta Logistica - International Scientific Journal
Volume: 1 2014 Issue: 2 Pages: 27-30 ISSN 1339-5629



# MANNER OF STOCKS SORTING USING CLUSTER ANALYSIS METHODS

**Jana Halčinová**
Technical university of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, e-mail: jana.halcinova@tuke.sk
**Jozef Živčák**
Technical university of Košice, Faculty of Mechanical Engineering, Department of Biomedical Engineering and Measurement, Letná 9, 042 00 Košice, e-mail: jozef.zivcak@tuke.sk
**Peter Trebuňa**
Technical university of Košice, Faculty of Mechanical Engineering, Department of Industrial Engineering and Management, Němcovej 32, 042 00 Košice, e-mail: peter.trebuna@tuke.sk

***Keywords:*** stock, cluster analysis, Ward's method, square Euclidean distance
***Abstract:*** The aim of the present article is to show the possibility of using the methods of cluster analysis in classification of stocks of finished products. Cluster analysis creates groups (clusters) of finished products according to similarity in demand i.e. customer requirements for each product. Manner stocks sorting of finished products by clusters is described a practical example. The resultants clusters are incorporated into the draft layout of the distribution warehouse.

## 1 Cluster analysis

Cluster analysis belongs to multivariate statistical methods [1]. It is defined as general logical technique, procedure which allows clustering various objects into groups – clusters on the basis of similarity or dissimilarity [2].

Having a data matrix *X* type *n x p*, where *n* is the number of objects and *p* number of variables (features, characteristics). Next there is a decomposition *S(k)* of set *n* objects to *k* certain groups (clusters), i.e.

$$S^{(k)} = \{C_1, C_2, C_3, ..., C_k\}, \quad (1)$$

[4]:

$$C_i \neq \emptyset, i = 1, ...k,$$

$\bigcup_{i=1}^{k} C_i$ comprises all the space.

If that set of objects $o = \{A_1, A_2, ..., A_n\}$ and any dissimilarity coefficient of objects *D*, then a cluster is called a subset of *p* sets of objects *o* to which it applies [4]:

$$\max_{i,j} D(A_i; A_j) < \min_{k,l} D(A_k; A_l), \quad (2)$$

where $A_i, A_j, A_l \in o$ a $A_k \notin p$. This means that the maximum distance of objects belonging to the cluster must always be less than the minimum distance any object from the cluster and object outside cluster.

The input for the clustering of the input data matrix and output is a specific identification of clusters. The input matrix *X* of size *n x p* contains the *i*-th row of characters $x_{ij}$ object $A_i$, where *i = 1, 2, ..., n* and *j = 1, 2, ..., p*. Therefor

$$X = \begin{pmatrix} x_{11} & x_{12} & \dots & x_{1p} \\ x_{21} & x_{22} & \dots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \\ & & & \end{pmatrix}. \quad (3)$$

Cluster analysis is a summary term for a group of methods that aim to either group the objects into clusters or clusters create a hierarchy of objects. Hierarchical cluster analysis methods analyzed classify objects into a hierarchical system of clusters. After this is important effective programming or utilization available softwares [3]. Between the hierarchical methods of cluster analysis method are simple linkage, complete linkage method, average linkage method, centroid method, median method, Ward `s method. Non-hierarchical methods do not create hierarchical (tree) structure and the objects are categorized into the number of disjunctive clusters specified in advance. Between the non-hierarchical cluster analysis methods of cluster analysis method are k-means, fuzzy clustering. In this paper was used hierarchical cluster analysis method - Ward's method and similarity were expressed by the square Euclidean distance.

Squared Euclidean distance is the basis Ward method of cluster analysis. The distance between the object resp. clusters is expressed as

$$d_{ES}(x_i, x_j) = \sum_{l=1}^{m} (x_{il} - x_{jl})^2. \quad (4)$$

Ward's method is also marked as a method of minimizing the increases of errors of sum squares. It is based on optimizing the homogeneity of clusters according to certain criteria, which is minimizing the

**MANNER OF STOCKS SORTING USING CLUSTER ANALYSIS METHODS**

Jana Halčinová; Jozef Živčák; Peter Trebuňa

increase of errors of sum squares of deviation points from centroid. This is the reason why this method is different from previous methods of hierarchical clustering, which are based on optimization of the distance between clusters [2], [4].

The loss of information is determined at each level of clustering, which is expressed as the increase of total sum of aberrance square of each cluster point from the average ESS value. Then comes to an connection of clusters where there is a minimal increase in the errors of sum of squares [2], [5].

The accruement of ESS function is calculated according to [2]:

$$\Delta ESS(A_i, A_j) = \frac{1}{2} d_{ES}(A_i, A_j),\ A_i, A_j \in o, \qquad (5)$$

where i,j =1,2,...,n.

### *1.1 Cluster analysis of stocks*

To perform the analysis are needed of data on the expedition of finished products particular company for the year [6]. Figure 1 shows the evolution of customer requirements resp. expedition during the year.

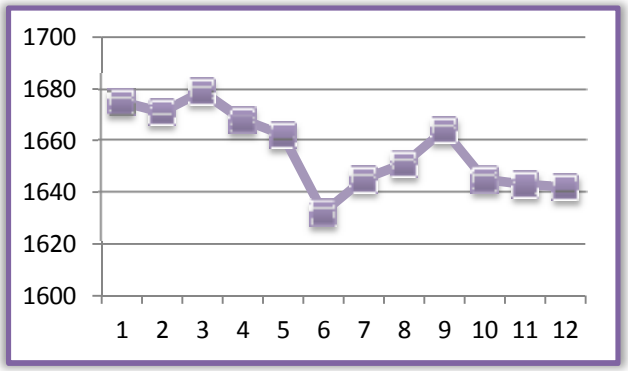



*Figure 1 Evolution of customer requirements resp. expedition during the year*

It can be seen that the evolution of customer requirements resp. expedition of finished products in the year 2013 has variable course. It can be seen that the evolution of means to customer ie. evolution dispatch of products has variable course, the average expedition represents 1,66 pcs of products per month, the greatest demand resp. export was observed in March of that year and the smallest demand resp. export was observed in June of that year. In some months of 2013 was created a single customer's request for the selected product.

Based on the input data on a monthly expedition of finished products for the customers in year 2013 was performed cluster analysis. The result of the process clustering is a dendrogram showing the different clusters according to the distance (dissimilarity) show in Figure 2.

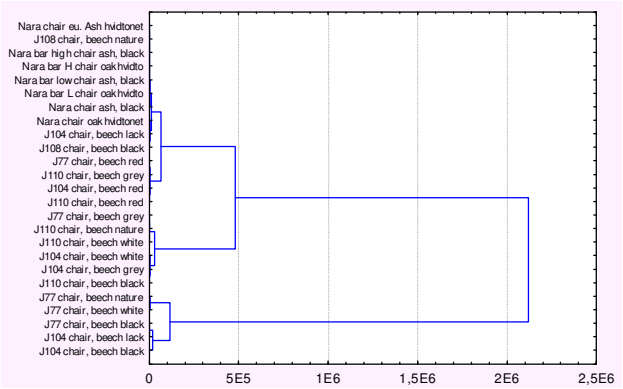



*Figure 2 Dendrogram of stocks*

Dendrogram is a graphic output of the cluster analysis, which shows clusters according to the distance (dissimilarity). Som other approaches for solving of analysis or sysntesis is described in the book *"Logistics of distribution"* [7]. The choice the clusters is on judgment of the solver [8], [9]. The optimal clusters are clusters of final products described in the Table 1.

*Table 1 Clusters of final products*

| | **Final products** |
|---|---|
| **1.cluster** | Nara chair eu. Ash hvidtonet |
| | J108 chair, beech nature |
| | Nara bar high chair ash, black |
| | Nara bar H chair oak hvidto |
| | Nara bar low chair ash, black |
| | Nara bar L chair oak hvidto |
| | Nara chair ash, black |
| | Nara chair oak hvidtonet |
| | J104 chair, beech lack |
| | J108 chair, beech black |
| | J77 chair, beech red |
| | J110 chair, beech grey |
| | J104 chair, beech red |
| | J110 chair, beech red |
| **2.cluster** | J77 chair, beech grey |
| | J110 chair, beech nature |
| | J110 chair, beech white |
| | J104 chair, beech white |
| | J104 chair, beech grey |
| | J110 chair, beech black |
| **3.cluster** | J77 chair, beech nature |
| | J77 chair, beech white |
| | J77 chair, beech black |
| | J104 chair, beech lack |
| | J104 chair, beech black |

**MANNER OF STOCKS SORTING USING CLUSTER ANALYSIS METHODS**
Jana Halčinová; Jozef Živčák; Peter Trebuňa

It was confirmed that the use of cluster analysis in sorting of stocks of finished products is justified because the clusters are formed on the basis of similarities in our case similarity of expedition to customers, which is the main criterion for the formation of groups of products towards our customers. Products with the greatest expedition should be placed closest to the exit. This criterion will then be taken into account when designing the layout. The percentage share of clusters on total expedition is graphically shown in Figure 3.

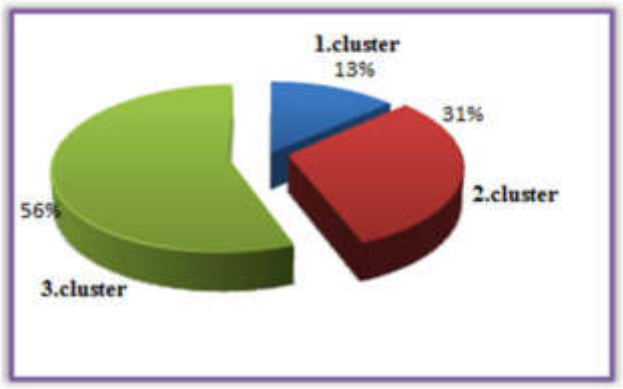



*Figure 3 The percentage share of clusters on expedition*

From the graphic illustration of Figure 3 follows that largest share of the expedition have products 3.cluster, then 2.cluster and the smallest share has 1.cluster. It is therefore appropriate stored of products 3.zhluku closer towards the exit in the warehouse of finished products. 3.cluster of products includes main groups of J77 and J104.

### *1.2 Draft of layout according clusters*

Draft of layout of distribution warehouse is shown in Figure 4 (2D layout), Figure 5 (3D layout). In the layout is marked clusters by the percentage of share in the expedition.

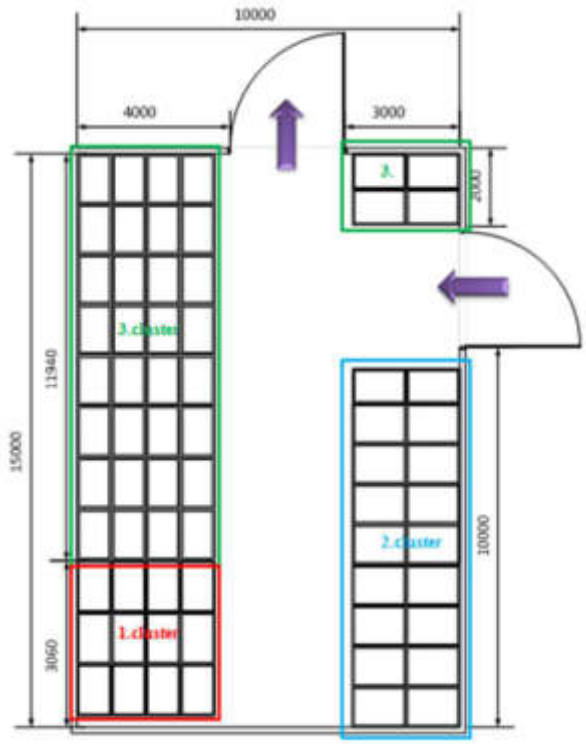



*Figure 4 2D layout of distribution warehouse*

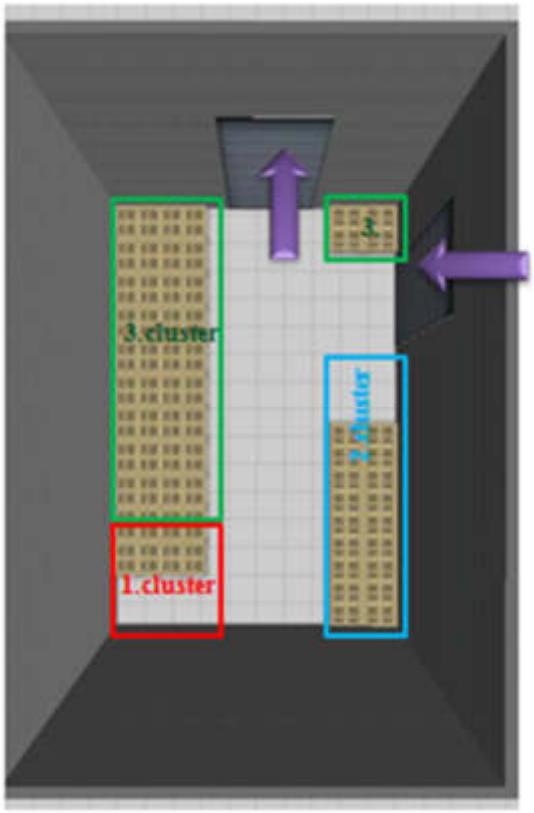



*Figure 5 3D layout of distribution warehouse*

## Conclusion

Described procedure of the application of cluster analysis in sorting of stocks is a systematic and logical. In the paper was applied for stocks of finished products. This procedure is applicable in all types of warehouses, in the input warehouse, in warehouse of auxiliary materials and in warehouse of finished products. When creating groups (clusters) of stock items using cluster analysis are necessary information about the process, which immediately followed, ie. for the analysis of stock items in output warehouse are input data of information on the expedition of products from previous years. When using cluster analysis in the development clusters of stocks depend on the type of stocks. The principle is also applicable in the field of ***supply of medical products***, where the criterion for the formation of clusters of stocks may be e.g. criterion storage conditions.

**Acknowledgement**

The article has been supported by the research grant No. ITMS 26220220185 of the project: University Medical Science and Technology Park in Košice (MediPark).

## References

[1] BACHER, J., POGE, A., WENZIG, K.: Cluster analysis - Application-oriented introduction to classification methods, Munchen, Oldenbourg, p. 432, 2010. (Original in German)
[2] BOŽEK, P., KŇAŽÍK, M., ŠTOLLMANN, V.: Conceptual planning and scheduling of operating funds for the real production of the company, Jaroměř, In: Technological forum, 5th International Technical Conference, Kouty, p. 192-198, 2014.
[3] TRNKA, K., PINTÉR, T., KŇAŽÍK, M., BOŽEK, P.: Effective programming of energy consumig industrial robot systems, Bratislava: STU in Bratislava, In: Power Engineering. Energy – Ecology – Economy, [Electronic], Conference EEE p. 4, 2012.
[4] EVERITT, B.S., LANDAU, S., LEESE, M., STAHL, D.: Cluster Analysis, London, Wiley, p. 348, 2011.
[5] HAN, J., KAMBER, M.: Data Mining – Concepts and Techniques, San Francisco, MK Publisher, p. 772, 2006.
[6] KAUFMANN, L.: Finding groups in data: an introduction in cluster analysis, Hoboken, Wiley, p. 342, 2005.
[7] STRAKA, M.: Logistics of distribution, How effectively to put product into the market, 1st edition, Bratislava, EPOS, p. 400, 2013. (Original in Slovak)
[8] TREBUŇA, P., HALČINOVÁ, J.: Experimental modelling of the cluster analysis processes, In: Procedia Engineering, Vol. 48, p. 673–678, 2012.
[9] ZGODAVOVÁ, K., ŽIVČÁK, J., HUDÁK, R., ČURILLA, E.: Quality in healthcare, Košice, Faculty of Mechanical Engineering TU in Košice, p. 141, 2013. (Original in Slovak)

**Review process**

Single-blind peer reviewed process by two reviewers.

# JOURNAL STATEMENT


| | |
|---|---|
| Journal name: | **Acta logistica** |
| Abbreviated key title: | Acta logist |
| Journal title initials: | AL |
| Journal doi: | 10.22306/al |
| ISSN: | 1339-5629 |
| Start year: | 2014 |
| The first publishing: | March 2014 |
| Issue publishing: | Quarterly |
| Publishing form: | On-line electronic publishing |
| Availability of articles: | Open Access Journal |
| Journal license: | CC BY-NC |
| Publication ethics: | COPE, ELSEVIER Publishing Ethics |
| Plagiarism check: | Worldwide originality control system |
| Peer review process: | Single-blind review at least two reviewers |
| Language: | English |
| Journal e-mail: | **info@actalogistica.eu** |


The journal focuses mainly for the original and new, interesting, high-quality, theoretical, practical and application-oriented contributions to the field of science and research as well as to pedagogy and education in the field of logistics and transport.


| | |
|---|---|
| Publisher: | **4S go, s.r.o.** |
| Address: | Semsa 24, 044 21 Semsa, Slovak Republic, EU |
| Phone: | +421 948 366 110 |
| Publisher e-mail: | **info@4sgo.eu** |


**Responsibility for the content of a manuscript rests upon the authors and not upon the editors or the publisher.**