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FEATURES OF FUNCTIONING OF TECHNOPARKS IN RUSSIA AND EU COUNTRIES

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Keywords: technology parks; authorities and administrations, sustainable development, innovative development, efficiency of activities
Abstract: The article is devoted to the analysis of the issues technoparks development in Russia and the EU countries. Method of system analysis; formal-logical method; method of comparative analysis; method of structural analysis is applied in the research. The study found that technology parks should maintain close ties with state agencies of all levels to achieve high efficiency. In turn, state structures can support the science park in many ways, as a founding partner, sponsor, service provider or client. The roles and responsibilities assumed by public authorities and administrations at various levels depend on their interest in the economic development of their territories, on the functional features and the management of technology parks. All these points must be taken into account by investors when they make a decision to participate in the technology park in a particular area.

1 Introduction

Technology parks all over the world act as specific instruments for solving both national and local / regional problems. These issues are actualized significantly at such stages of social development as economic stagnation, crisis, post-crisis recovery of economy, which fully applies to the current situation in the global economy in general, and in Russia in particular [1,2].

It should be noted that, despite attempts to scale down public funding of research section and various supporting institutions recently undertaken abroad, high importance of public assistance in addressing issues of innovation development, business start-ups, technological upgrading, sustainable development of the economy, maximizing the scientific and educational potential of countries and regions to ensure economic growth and innovation development remains and has increased recently [3-6].

2 Theory and methodology of the study

The theoretical basis of the research is domestic and foreign approaches to the analysis of the efficiency of technology and science parks in different countries. Public support of technology business incubators in technology and science parks [7-9], networking of technology parks and business incubators [10,11], changing of approach to generating demand and supply for business incubators of different generations [12-14] have been actively discussed in recent decades. Several issues related to the organization of the efficient functioning of technology parks and business incubators, including in developing countries [15,16] were raised in foreign and domestic research, such as their funding from various sources, including public funds [17], the development of small innovative enterprises [18]. Special reviews of best practices are used as a basis for analysing the features of foreign technology parks and business incubators [15,19-22], as well as official analytical reviews of the EU [23, 24].

The results of a survey conducted in 2012 by experts of the International Association of Science Parks (IASP) [25] among residents of 129 scientific and technological parks in EU and other IASP information material (in total the association includes more than 360 technological and scientific parks from all European countries) are used as a statistical and informational basis.

Study of functioning of the best technology parks in Russia was carried out on the basis of official information on their activities, as well as special scientific research in particular regions and technology parks [26-29].

3 Results of the study

The survey results showed that the universities (in total – 95 %) received the highest assessments of impact on the success of functioning of science and technology parks, 66.1% of the respondents rated universities as very important. Also, the majority of respondents (84%) assess the direct involvement of public authorities at all levels (local, regional and / or national) in the activity of technoparks as important, 58.1% of respondents rated it as "very important". Thus, the most important partners (more than 50% of responses) for residents of European technology parks, are (in decreasing order of aggregate amount of answers) universities and government organizations, external investors, banks and financial institutions. It should be noted that Russian researchers [30-35].) point out a special role of universities, as well as for the scientific and educational environment in general, for successful innovation development and establishment of technology parks and business incubators.

Another important issue is the issue of the involvement of public authorities and administrations at various levels in functioning of technology parks as their founders and property owners. The study of the form of ownership of technology parks in EU showed that most of them are characterized by the prevalence of public or mixed forms of ownership. The public sector's sharemakes up almost 55% of all property and it clearly dominates over other forms of ownership when creating technoparks and science parks in EU.

The mixed form of ownership is represented by the association of several owners. The mixed form of ownership, which accounts for slightly more than 30%, is represented by the combination of several owners, both private property owners and government structure, with a large number of co-owners in European technology and science parks the number of co-owners of property per technopark is on average 3.3 owners (in some technoparks this value is more - up to 5-7 co-owners). (see Table 1, compiled by Setting up, Managing and Evaluating EU Science and Technology parks [23]). Private ownership, which includes only individuals, representing the sole owner is only 14.5%, in the general structure of ownership of technological and scientific parks in the EU

Table 1 Structure of owners of mixed ownership of EU technological and scientific parks

Ownership	Proportion in the total volume of mixed ownership
Local authorities and administrations	89.9%
Regional authorities and administrations	10.5%
National authorities and administrations	10.5%
State universities	57.9%
Private universities	5.3%
State banks	21.1%
Public funds	10.5%
Private funds	31.6%
Chambers of Commerce and Industry	21.1%
Private companies	52.6%
Other organizations	21.1%

Table 1 shows that the dominant owners of mixed ownership in European technology and science parks are local authorities and administrations (89.5%), and among private owners - private production companies that control more than 50% of the total size of the mixed form of ownership of technoparks. Private universities and funds make up about 33% of private sector owners in technoparks. As for Russian technoparks, the analysis showed the following.

Having various possibilities for attracting public sources of support for technology parks has led to forming various types of technology parks that differ in their forms of ownership (founders), basis for appearance, and peculiarities of functioning. All these types can be grouped into several groups (Table 2).

Table 2 Grouping of Russian technoparks by forms of ownership and features of functioning

Name of group	Features
Technoparks - commercial projects	The business model of such technoparks is built in such a way that the management company takes financial part in the projects of residents, i.e. participates in the creation of successful technology businesses to meet the needs of the market in new high-tech developments. The effectiveness of this business model is confirmed by the high level of employment of leasable areas of the technopark by residents to 96 %
Technoparks - the academic environment with public-private partnership	The factor to successof such technoparks is in close proximity to large scientific centers with high concentration of academic environment. They are the center of attraction not only for research staff but also for small innovative and start-up companies interested in mutually beneficial cooperation with scientific and educational research institutions in order to use their human and scientific potential and developed technological base, as well as experience in implementing scientific ideas
Technoparks of state ownership with special	The business model of these technoparks is characterized by the existence of the most favorable

conditions for residents	conditions for residents. The group is represented by technoparks in Moscow, where the functioning of technoparks is carried out in close cooperation with the Department of Science, Industrial Policy and Entrepreneurship of Moscow with the active support of the Moscow City Government.
Technoparks - members of the European Community Business and Innovation Centres (EBN)	The business model is accredited by the European Community, fully complies with the requirements of European standards. It is characterized by a developed infrastructure supporting the development of small and medium innovative, including nanotechnology businesses.
Technoparks created through the implementation of the comprehensive program "Establishment of Technoparks in the Sphere of High Technologies in the Russian Federation"	They were created on the initiative of the regional authorities with the support of the Ministry of Communications and Mass Media of the Russian Federation with the aim of developing new high-tech companies. The activity is aimed at comprehensive support of projects at all stages of the innovation process: from the creation of a prototype to the introduction of new technologies into batch production.

As it can be seen from Table 2, there is a sufficiently large variety of technoparks in Russia according to the forms of ownership, the basis of appearance and the features of functioning. This creates a broader basis for ensuring the successful development of technology parks in the country, depending on the goals and objectives of their functioning.

A more detailed analysis of the ownership structure of Russian technology parks showed that it is characterized by the predominance of state ownership, including the most effectively functioning technology parks. In particular, among 10 most efficient technoparks in Russia there are 6 technoparks with state ownership, 2 technoparks with state-private ownership and only 2 technoparks with a private ownership.

The list of these technoparks with the indication of the form of ownership and the main sources of financing their activities is given in Table 3.

Table 3 The rating of technoparks with a high level of operational efficiency (above the Russian average by 10% or more)

№	The name of the technopark	Form of ownership	Sources of funding
1.	Nano-technological centre "Technospark", Moscow	Private	Extrabudgetary funds
2.	Science Park of Moscow State University, Moscow	State-Private	Federal Budget Extrabudgetary funds
3.	Science and Technology Park of Novosibirsk Science Campus (Academpark), Novosibirsk Region	State	Federal Budget Regional budget Municipal budget Extrabudgetary funds
4.	Technopolis "Moscow", Moscow	State	Regional budget Extrabudgetary funds
5.	Technopolis "Strogino", Moscow	State	Federal Budget Regional budget
6.	Innovation and production technopark "Idea", Republic of Tatarstan	Public-Private	Federal Budget Regional budget
7.	Autonomous Institution "Technopark - Mordovia", Republic of Mordovia	State	Federal Budget Regional budget Extrabudgetary funds
8.	Ulyanovsk nano-technological center, Ulyanovsk region	Private	Extrabudgetary funds
9.	AST "West-Siberian Innovation Center (Tyumen Technopark), Tyumen Region	State	Federal Budget Regional budget
10.	Technopark in the sphere of high technologies	State	Federal Budget Regional budget

	"IT Park", Kazan, Republic of Tatarstan		

The national leader in the number of technology parks is Moscow (30 objects or about 28 % of all technoparks in Russia), Sverdlovsk Region (9 objects), followed by the Republic of Tatarstan (8 sites), the Moscow Region (6 facilities) and the city Novosibirsk (5 sites). At the same time, different regions demonstrate different volume, level and directions of regional and local support of the created technoparks.

The high concentration of technology parks in Moscow and the high level of efficiency of their functioning (the four technoparks of Moscow are among the top ten most effective technology parks in Russia: the Technopark Nanotechnology Center, Moscow State University Science Park, Moscow Technopolis and Strogino Technopolis) is due to the high interest of Moscow Government in the creation of specialized sites for the development of high-tech companies, a high concentration of scientific and educational institutions, which have substantial groundwork for the development of high-tech economic activities and scientific research, as well significant number of industrial facilities best suited to forming of technology parks. The interest of the Government of Moscow is also focused on providing substantial quantities of preferences for residents and management companies of technoparks, which cannot be found in other regions. For example, despite the high concentration of technoparks in the Republic of Tatarstan, regional authorities do not grant benefits to residents of the technopark, and in Tyumen and Ulyanovsk regions there are no benefits for anyone, including management companies of technoparks.

In addition to the 10 most efficient technology parks, 8 technoparks with an average level of efficiency of functioning (10-85% of the average) are of interest. These are such technological and scientific parks as the Technopark of High Technologies of the Khanty-Mansiysk Autonomous Region-Ugra, Technopark in the High-Tech Industry Zhigulevskaya Dolina (Samara Region), Technopark in the High Technologies Area, IT Park (Naberezhnye Chelny), Technopark Slava Moscow, Technopark Mosgormash, Kosmos-Neft-Gaz (Voronezh Region), Industrial Technopark IKSEL (Vladimir Region), Composite Materials and Fibers (Republic of Dagestan).

4 Conclusion

A comparative analysis of the socio-economic and technological development of the regions with the best functioning technology parks, has shown that among the leaders there are those technoparks that are created and function in RF regions with a developed structure of industrial production, a high concentration of human and intellectual capital, and also constant leaders in various ratings assessing the level of socio-economic status, investment attractiveness, innovative development and so on. The main key factors in the efficiency of functioning of the mentioned technoparks can be considered:

- Close proximity to major scientific centers and academic environment (MSU Science Park, Science and Technology Park of Novosibirsk Science Campus (Academpark)).
- High interest of regional government bodies in diversifying the economy and following the Strategy of Russia's scientific and technological development and corresponding regional strategies (Innovation and Production Technopark "Idea", AST"West-Siberian Innovation Centre (Tyumen Technopark)).
- Presence of extra-budgetary financing, when private investors are focused on meeting market needs, including high-tech developments (Nanotechnology Centre "Technospark", Ulyanovsk Nanotechnology Centre).
- Effective fiscal and financial support of the technopark from the regional authorities (Technopolis Moscow, Technopolis Strogino, Autonomous Institution Technopark-Mordovia).

The study of the mechanism of creation and forms of ownership of domestic technology parks showed that technological parks with all basic forms of ownership have been formed and are functioning successfully in Russia. At the same time, the state order is one of the most important sources of funding for technological parks, both abroad and in Russia.

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References

[1] STAUDT, E., BOCK, J., AND MUHLEMEYER P.: Technology centres and science parks: agents or competence centres for small businesses? *International Journalof Technology Management*, Vol. 9, No. 2, pp. 196-212, 1994. doi:10.1504/IJTM.1994.025570.
[2] VEREMEENKO, S.A., SMETANOV, A.YU.: Strategy of support of small high-end business in the conditions of financial crisis, *Higher education today*, Vol. 2015, No. 4, p. 56-59, 2015. (Original in Russian)
[3] BAGRINOVSKY, K.A., BENDIKOV, M.A., KHRUSTALEV, E.YU.: *Mechanisms of technological development of the Russian economy: Macro and*

mesoeconomic aspects, Moscow, Nauka, 2003. (Original in Russian)

[4] LYASHENKO, E.A.: Evaluation of the dynamics of the development of technopark structures in the Sverdlovsk region, *Izvestiya Ural State Economic University*, Vol. 56, No. 6, p. 86-94, 2014.

[5] RADIONOVA, E.A, GRITSKIKH, N.V.: About the state support of development of technoparks as a basic element of innovative infrastructure, *New science: Theoretical and practical view*, Vol. 75, No. 4-1, p. 156-159, 2016.

[6] CALVO, N., RODEIRO-PAZOS, D., FERNÁNDEZ-LÓPEZ, S.: Science and technology parks as accelerators of knowledge-intensive business services, A case study, *International Journal of Business and Globalisation*, Vol. 18, No. 1., pp. 42-57, 2017. doi:10.1504/IJBG.2017.10001185

[7] ABETTI, P.A.: Government-supported incubators in the Helsinki region, Finland: infrastructure, results, and best practices, *The Journal of Technology Transfer*, Vol. 29, No. 1, p. 19-40, 2004.

[8] ATHERTON, A., HANNON, P.D.: Localised strategies for supporting incubation: strategies arising from a case of rural enterprise development, *Journal of Small Business and Enterprise Development*, Vol. 13, No. 1, p. 48-61, 2006.

[9] TANG, M.F., LEE, J., LIU, K., LU, Y.: Assessing government-supported technology-based business incubators: Evidence from China, *International Journal of Technology Management*, Vol. 65, No. 1-4, p. 24-48, 2014. doi:10.1504/IJTM.2014.060956

[10] SCHWARTZ, M., HORNYCH, C.: Cooperation patterns of incubator firms and the impact of incubator specialization: empirical evidence from Germany, *Technovation*, Vol. 30, No. 9, p. 485-495, 2010.

[11] BOLLINGTOFT, A.: The bottom-up business incubator: leverage to networking and cooperation practices in a self-generated, entrepreneurial-enabled environment, *Technovation*, Vol. 32, No. 5, p. 304-315, 2012.

[12] BRUNEEL, J., RATINHO, T., CLARYSSE, B., GROEN, A.: The evolution of business incubators: comparing demand and supply of business incubation services across different incubator generations, *Technovation*, Vol. 32, No. 2, p. 110-121, 2012.

[13] MONTONEN, T., ERIKSSON, P., ASIKAINEN, I., LEHTIMÄKI, H.: Innovation empathy: A framework for customer-oriented lean innovation, *International Journal of Entrepreneurship and Innovation Management*, Vol. 18, No. 5/6, p. 368-381, 2014. doi:10.1504/IJEIM.2014.064719

[14] ERIKSSON, P., VILHUNEN, J., VOUTILAINEN, K.: Incubation as co-creation: case study of proactive technology business development, *International Journal of Entrepreneurship and Innovation Management*, Vol. 18, No. 5/6, p. 382-396, 2014.

[15] CORREIA, A.M. M., DE LOURDES BARRETO GOMES, M.: Potentialities and limits for the local economic and innovative development: a comparative analysis of technology parks located in the Northeast region of Brazil, *International Journal of Innovation and Learning*, Vol. 15, No. 3, p. 274-298, 2014. doi:10.1504/IJIL.2014.060877

[16] DHEWANTO, W., LANTU, D.C., HERLIANA, S., PERMATASARI, A.: The obstacles for science technology parks in a developing country, *International Journal of Entrepreneurship and Innovation Management*, Vol. 8, No. 1, p. 4-19, 2016. doi:10.1504/IJTLID.2016.075180

[17] SCANDIZZO, P.L.: Financing technology: an assessment of theory and practice, *International Journal of Entrepreneurship and Innovation Management*, Vol. 32, No. 1/2., p. 1-33, 2015. doi:10.1504/IJTM.2005.006816

[18] MINGALEVA, Z., MIRSKIKH, I.: Small innovative enterprise: The problems of protection of commercial confidential information and know-how, *Middle East Journal of Scientific Research*, Vol. 13, SPLISSUE: p. 97-101, 2013.

[19] BERGEK, A., NORRMAN, C.: Incubator best practice: a framework, *Technovation*, Vol. 28, No. 1, p. 20-28, 2008.

[20] NOSRATABADI, H.E., SHABANI, R., FAZLOLLAHTABAR, H.: A hybrid FGAHP-ME methodology for evaluating science and technology parks with pairwise comparison analysis, *International Journal of Entrepreneurship and Innovation Management*, Vol. 13, No. 2, p. 133-153, 2013. doi:10.1504/IJISE.2013.051789

[21] ERIKSSON, P., MONTONEN, T., VILHUNEN, J., VOUTILAINEN, K.: Incubation manager roles in the co-innovation context, *International Journal of Entrepreneurship and Innovation Management*, Vol. 20, No. 5/6, p. 285-299, 2016. doi:10.1504/IJEIM.2016.10000638

[22] SHAIDUROVA, N.S.: Comparative analysis of the concepts of the technopark movement in different countries, *Economics and Entrepreneurship*, No. 12-2 (65-2), p. 980-983, 2015.

[23] European Commission: *Setting up, Managing and Evaluating EU Science and Technology parks*, An advice and guidance report on good practice, Luxembourg, Publications Office of the European Union, p. 211, Oct., 2014. Available: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/stp_report_en.pdf, doi:10.2776/7340, 2014.

[24] European Commission, *Benchmarking of Business Incubators*, Final report, Centre for Strategy & Evaluation Services, Feb. 2002. Available: https://www.google.sk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjBh_u1__3YAhXQzqQKHe7JB-

EQFggnMAA&url=http%3A%2F%2Fec.europa.eu%2FDocsRoom%2Fdocuments%2F2769%2Fattachments%2F1%2Ftranslations%2Fen%2Frenditions%2Fpdf&usg=AOvVaw1qVwpWnC2_yj6FXD8XTP2U, 2002.

[25] IASP (International Association of Science Parks). 2012, world stp statistics, Available: http://www.iasp.ws/statistics, 2012.

[26] LYASHENKO, E.A.: *On the problems of financing technopark structures as institutes of innovative development of the region*, In the collection: Proceedings of the Ural State Economic University: a collection of scientific articles. Ekaterinburg, 2016, p. 82-87, 2016.

[27] KOTELNIKOV, N.V., NAGAEVA, A.V.: Analysis and prospects for the development of the technopark as an object of innovation infrastructure, Bulletin of the Tomsk Polytechnic University, *Engineering georesources*, No. 6., p. 126-133, 2014.

[28] GAIDARULY, E., MALININ, V.L.: Comparative analysis of business incubators and technology parks in different regions of the Russian Federation, *Young Scientist*, No. 1 (105), p. 329-335, 2016.

[29] MINGALEVA, ZH.A., SHAIDUROVA, N.S.: Interaction of state and local authorities in the creation and development of technology parks, *Ars Administrandi*, Vol. 9, No. 2, p. 176-194, 2017. doi:10.17072/2218-9173-2017-2-176-194.

[30] ARISTOV, M.V., ARISTOV, V.M.: Technoparks in Russia - innovations to improve the quality of educational services, *Scientific notes of the International Banking Institut*e, No. 9, p. 127-130, 2014.

[31] SVIATSKII, V., REPKO, A., JANAČOVA, D., IVANDIČ, Z., PERMINOVA, O., NIKITIN, Y.: Regeneration of a fibrous sorbent based on a centrifugal process for environmental geology of oil and groundwater degradation, *Acta Montanistica Slovaca*, Vol. 21, No. 4, p. 272-279, 2016. http://actamont.tuke.sk/pdf/2016/n4/2sviatski.pdf

[32] LURIE E.A.: University technopark: the time of recognition, *Innovations*, No. 5 (175), p. 3-16, 2013.

[33] MAYUROVA, A.S., KUSTIKOVA, M.A., MAYUROVA, M.V.: Technoparks of Russia are a reliable partner for education, *On the way to a new school*, No. 2, p. 93-95, 2014.

[34] MINGALEVA, ZH., MIRSKIKH, I.: On innovation and knowledge economy in Russia, *World Academy of Science, Engineering and Technology*, No. 66, p. 1032-1041, 2010.

[35] ROGOVA, E.M.: Efficiency of the functioning of business incubators as an element of the spin-off strategy of universities, *Innovations*, No. 10 (180), p. 58-63, 2013.

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CASE STUDY OF OPTIMISATION MATERIAL REPLENISHMENT SYSTEM VIA PRINCIPLES OF LOGISTICS

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Keywords: logistics, replenishment, material, standard work, inventory, supplying

Abstract: The system of supplying production cells, production lines, warehouses are an inherent process without which it could not be produced. It is precisely for the responsibility and importance of this process that in practice, logistic processes are over-sized or efficient, but with a great deal of waste, just for safety, so that production is not compromised. There are a number of supply systems and principles, even almost fully automated, but they are still relatively inaccessible to many businesses. Therefore, this article approaches how the supply system can be simplified and streamlined.

1 Introduction

The article was created on the basis of a case study from practice. The topicality of the article also suggests the situation in almost every industry sector where there is pressure to increase process efficiency to increase competitiveness. Efficiency in the process can be understood as the performance or operation of the process with minimal cost, while respecting its quality. This process efficiency can be searched for, respectively. in the process of production of products, but also in the process of supplying production lines, i.e. in service and logistics processes. The article compares the production line supply to the Milk Run delivery system, but without fixed time circuits and standardized work with the Milk Run system, along with a precise route, time and standard operations.

2 Data and methodology

The following figure (Figure 1) captures the material flow of the production supply process in the state of the art:

Figure 1 Flow of material in the current state of supply
Source: Internal document of company, edited by author

The image captures the flow of material while supplying small warehouses near workplaces and also supplying workstations from small warehouses. The potential for the use of the rectangular layout of the production hall is relatively unused and the flow of material is considerably complicated precisely because of the need to pass through workplaces (production sections).

Waste arising from this supply system:

- Long travel distances - Worker usually walks on foot and pushes the trolley with the material
- Crossing workplaces - risk of injury
- Small warehouses are created in the workplace - inventory is not performed, unknown inventory
- Fatigue of the linefeeder, fluctuation – it is not possible to accurately map what movements it performs

In the future state, it is necessary to make several changes in the distribution of supply points in order to increase the efficiency of supply, thereby creating a new logistics system. The system consists of a set of elements between which there are bonds, relationships, and which has a certain level of organization [1]. The point of supply was transformed from a partial storage zone to a shelf within the operator's direct reach at the workplace. All material stored in the workplaces will be centralized, stored and picked in a supermarket - a central warehouse.

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Figure 2 Visualization of material flow with new supply points
Source: Internal document of company, edited by author

Supply logistics resolves the clearance and inspection of goods, storage and warehouse management, in-house transport, planning, management and control of material and information flows [2]. Supplying material to newly designated supply points will result in a reduction in inventory of material at workplaces. The material imported in the past to the partial storage sites at the workplaces will be stored in the supermarket and the new supply points will only be sized for the required amount of material calculated for the time span of the workstation inventory necessary for continuous production between the two supply cycles.

New supply points (Figure 2) are for production cells:
- C1 – Test line.
- C2 – Small assembly.
- C3 – Test line.
- C4 - Large assembly.
- C5 – Medium assembly.
- C5 – Warehouse of small parts.
- C6 – Test line.
- C6 – Welding line.
- C7 – Assembly line.
- C7 – Assembly line.

Supply points are "pulled out" to the main traffic lane compared to the current state. The potential for the use of the rectangular shape and the deployment of individual operations was relatively little used. In spite of the simple "layout", the linefeeder was forced to pass through individual workplaces, which significantly prolonged the time needed to fill the material in the workplaces. The layout of production operations is linked to two types of aisles:
- Main aisle (horizontal).
- By the side aisle (vertical).

To eliminate the passage of the supply while supplying through the alleyways and through the workplaces, new supply points for manufacturing operations were located on the main horizontal aisle. This placement should contribute to simplifying material flow, speeding up supply and shortening supply routes, as it eliminates unnecessary routes through workplaces. Material flow is an important factor in the design of production systems [3,4].

Based on this simplification of the supply route, you can create a standard supply worksheet and create the time standard itself. Supply circuit of linefeeder will always begin and end at one point and the point will be a centralized component store. In the central warehouse there will be loading of full packing, picking up of material and also unloading and storing empty returnable containers. The supply route will only lead along the main aisle with pockets near the assembly sites, testing, welding lines and connector stores.

During the supply, a wheeled tractor will be used to pick up all the necessary parts in each circuit. Such a solution also takes account of ergonomics at work and also the reasonable load of the logistics operator during the supply of lines through work change. In the future, in the time of a possible increase in production, in the case of the incorporation of new machines into production, the tugger will be equipped with a further set of peripherals as required for the material to be transported, thus ensuring efficient supply from the central warehouse to workplaces.

Figure 3Visualization of tugger with hardware, Source: Internal document CEIT Pro, Ltd.

For the purpose of this work, the standard times of individual actions were defined on the basis of professional literature. The data in the table (Table 1) was used in the calculations of individual standard times in the established logistics. The design of the bench supply with ideal working conditions for use in the real system is subject to verification by in-service testing.

Table 1 Standard times for standard work calculation

1 step (approx. 90 cm) = 0.6 s.
Transport time (typical tractor speed is 4 km / h) = 1.1 m/s.
Get in tugger = 3.9 s.
Get off from tugger = 3.9 s.
Unloading transport unit = 7.0 s./transport unit
Loading the transport unit = 7.0 s./transport unit

Table 2 Proposal of standard work sheet for linefeeder

Standardized work of linefeeder					
	Direction	**Activity**	**Parts**	**Duration**	**Transport time**
1	From central warehouse to supply points C7	Deliver, unload, load parts	Component 1	147.8 s.	13.63 s.
2	From point C7 to point of supply C6	Deliver, unload, load parts, unpack the packaging	Component 2	147.8 s.	18.18 s.
3	From point C6 to assembly line C5	Deliver, unload, load parts and components	Component 3	179.8 s.	27.27 s.
4	From point C5 to assembly line and tester C4	Deliver, unload, load parts and waste	Component 4	89.8 s.	45.54 s.
5	From point C4 to test line C3 TL	Deliver, unload	Component 5	21.8 s.	13.63 s.
6	From point C3 TL to point of supply C2	Deliver, unload, load parts and waste	Component 6	147.8 s.	27.27 s.
7	From point C2 to point C1 TL	Deliver, unload	Component 7	21.8 s.	36.36 s.
8	From point C1 TL to central warehouse	Unload empty containers and load full	-	287.8 s.	181.81 s.
Overall:				1044.4 s.	363.69 s.
Total supply time:				**1408.09 s. (23.47 min.)**	

3 Results

Since the calculation for standardization of the supply process in the supply chain in the Milk Run and Kanban style supply workflows with the empty shelf signal in the racks, the time came to a circle of 23, 47 minutes, which is about 40% of the time in one hour (Table 2). Therefore, it is possible to introduce a 1 hour supply chain in the company, which represents during work shift in production:

Work shift = 8 hours 30 minutes – 30 minutes lunch break = clear time 8 hours / shift

8 hours / 1 hour circuit = 8 supply circuits / shift

Advantages of 1 hour supply circuit:

- Logistics operator passes every workplace in the company every hour

- In case of an unscheduled change in the production order, the material can be delivered within an hour.
- It can flexibly respond to changes and requirements of production lines.
- He has a clear idea of the state of inventory in each workplace.
- Enough time for other activities.
- Can provide a clear report on the stock status of the individual materials in the warehouse.

With a supply time for one circuit of approx. 24 minutes, along with the loading of the required workplace material and unloading of empty packaging in the warehouse, there remains plenty of time for other operator activities outside the Milk Run supply, such as:

- Disposal of waste from workplaces.
- Charge the trolley battery.
- 5S

4 Conclusion

Comparison of supply times in the current state and in the proposed state is not possible because the supply circuit has not been made or defined in the current state. However, it is clear from the material flows that the proposed circuit will save considerable time. The article highlights the fact that a relatively simple adjustment of the system can be more efficient in the production supply process, possibly gaining time and capacity of human resources for irregular activities that no one has in standard work in the company.

References

[1] STRAKA, M.: Simulácia diskrétnych systémov a simulačné jazyky, Editačné stredisko/AMS, Fakulta BERG, TUKE, Košice, 2005. (Original in Slovak)
[2] TOMEK, G., VÁVROVÁ, V.: Malý výkladový slovník marketingu, aplus, Praha, 1997. (Original in Slovak)
[3] TANCHOCO, J.M.A.: Material Flow Systems in Manufactoring, Chapman & Hall, London, 1994.
[4] GHIANI, G., LAPORTE, G., MUSMANNO, R.: Introduction to Logistics Systems Management, Johny Wiley & Sons, Ltd., UK, 2013.

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PROJECT OF INFORMATION SYSTEM FOR THE NEEDS OF LOGISTIC CONFERENCES ORGANIZED BY DEPARTMENT OF LOGISTICS

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Keywords: information logistics, conference, projecting, internet conference system, programming
Abstract: In the modern world there is a huge demand for exchange and sharing of information. Members of Department of Logistics at Technical University of Kosice are therefore participating in many international conferences. In order to be able to create and organize scientific conference they needed to create a web conference system. This information system combines the advantages of available conference systems and the requirements of Department of Logistics. It incorporates features such as information elements, sections for the purpose of advertising, marketing and propagation and elements for financial flows. Web conference system with the name *ConfUL* solves the difficulties that have appeared within organization of scientific conferences and ensures optimal informational and financial flows. Users of *ConfUL* system are allowed to add and share scientific articles, search for instructions and information about the upcoming conferences and many more. In this article we present the basic functions of web conference system *ConfUL*.

1 Introduction

Conferences are closely bound up with activities of scientific organizations and institutions. Conferences provide for employees and students of these organizations and institutions an effective and attractive introduction of their scientific work. Department of Logistics uses conferences for publishing new knowledge and exchange of information with other organizations. However, organization of conference without appropriate information system can be very difficult.

Organization of conferences requires maintaining of numerous information flows between the organizators and the participants of the conferences [1]. These information flows connect organization terms, financial or marketing information. To ensure, that such big amount of different information will always reach the right person in the right time is very challenging, especially when the conference will host many participants from different countries [2]. Modern technology makes the organization significantly easier thanks to web conference systems. Online we can find a whole variety of conference systems, but most of them are limited or charged and they do not suit our needs. We have analysed available conference systems and created our own web conference system with features that meet the demands of Department of Logistics.

Organization of conferences requires many information flows between organizators and participants. Except for basic information about conference we also need to specify information about accommodation for participants, payments, papers for conference, instructions for authors, program, information for sponsors and many others. This exchange of information must be fast, actual, reliable and mutual [3].

Usage of web conference system can bring us the following advantages: reduction of organization exactingness, fast information flows between organizators and participants, space for unlimited quantity of new conferences, elimination of mistakes caused by a human factor, elimination of financial and time losses and many others.

2 Parts of web conference system

Basic elements of web conference systems are human part of the system, functional part, software and information technologies [4]. On the lower levels of hierarchy can be these elements considered as independent systems which consist of other elements as shown in Figure 1.

Figure 1 Parts of web conference system

Human part of the system can be divided into programators, administrators of the system and users. Also users can be divided into organizers, reviewers, authors and participants on lower level of hierarchy. Each one of these roles has different access to functions and permissions (adding, approving, erasing of the articles, users and conferences, changing the basic information about conferences or adjusting the system itself). The rights of the roles are discussed separately in the chapter number 3.

Each web conference system can be created by using different software and programming approach. The most common is the combination of programming language PHP and database MySQL. This software can be downloaded freely and have allowed us to create the basic system structure. The functions of the system are linked with the database using the PHP programming language [5].

The functional part of the system provides the functions for users, that depend on individual conference systems. Each system offers a few special functions in order to distinguish itself from the others, but there are also common basic functions for each system, that are shown in Figure 2.

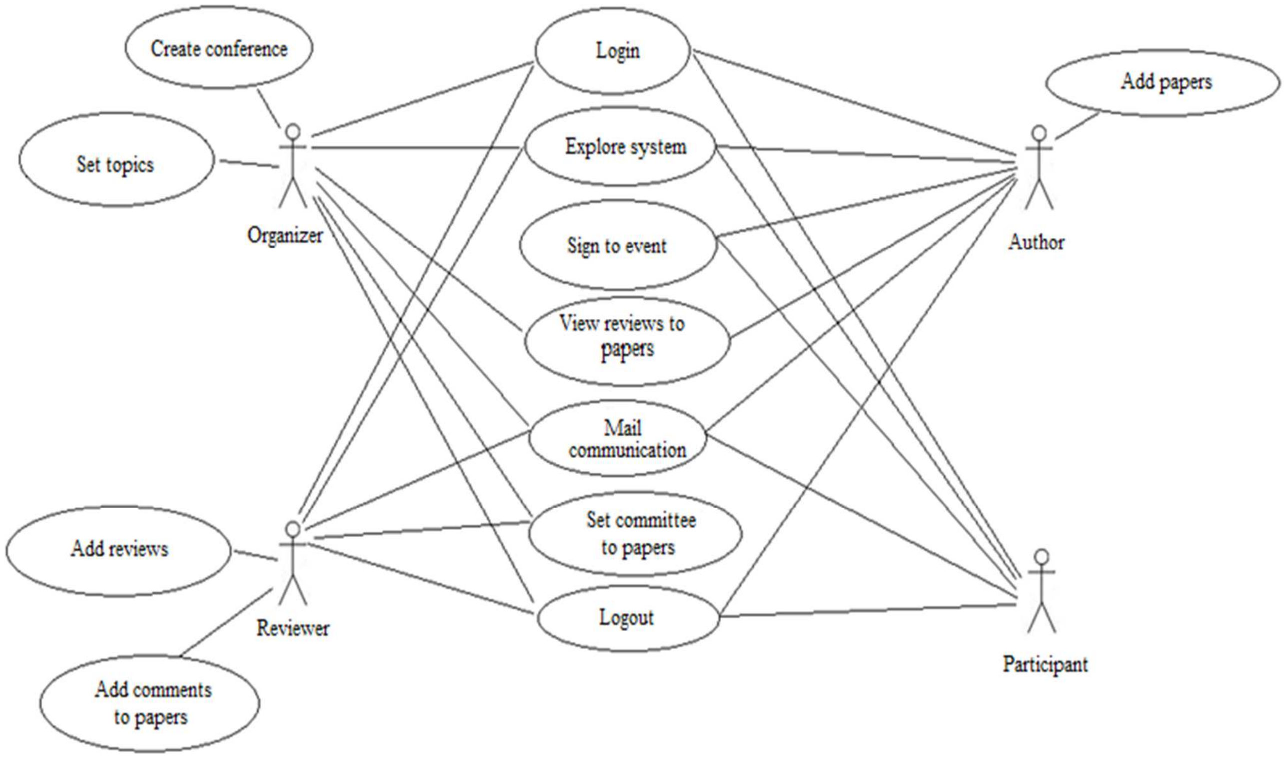

Figure 2 Users functions

The most interesting systems suitable for organization of conferences are web conference systems *ConfTool*, *EasyChair*, *OpenConf* and for us is also very interesting information system of company *TANGER, Ltd.* These systems are available and very effective for organization of conferences. After system analysis of the available web conference systems we have decided to combine the basic functions of these systems. We have created the new web conference system for UL TUKE called *ConfUL* – Conference system of UL TUKE [6].

3 Roles and permissions of users

ConfUL divides users into organizers, authors and participants. User in the role of organizer can create unlimited number of conferences, he sets information about conferences such as title, dates and place of event, terms for closing of registration to conference. He also sets the topics for conference, program and other information. The organizer can search every paper added to conference, confirms or rejects user's demands to be co-organizator to actual conference.

The role of author can add paper to conference and can create order to conference in order form set by organizer.

The role of participant can create order and sign to conference, even if he does not want to add paper and presentation to conference.

The administrator of the system can manipulate with all system functions, can be in the role of organizer, but he also has some specific permissions – he is allowed to erase all the conferences. The web conference system *ConfUL* and its functions are described in the following chapter.

4 Basic functions of *ConfUL* system

Our goal was to create web conference system as a tool allowing the members of the Department of Logistics for simple, fast and effective organization of conferences.

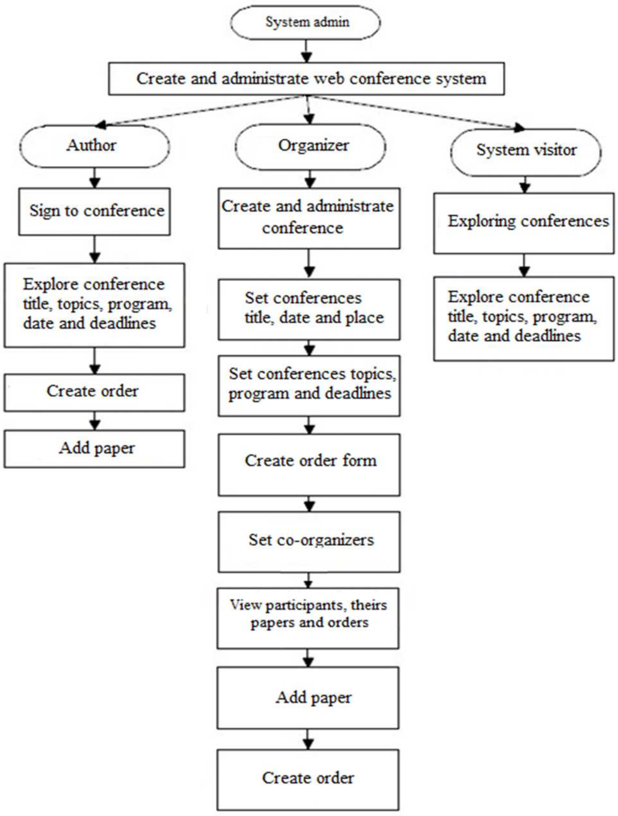

Figure 3 Functions of ConfUL

ConfUL represents a user friendly and reliable system (Figure 3) capable of transmitting big amount of information between its users and database in the real time. As programming languages we used *PHP*, *Html*, *CSS* and also the database *MySQLi*.

Figure 4 Display event

Home page (Figure 4) of the system shows all created conferences and by clicking the „Detail Conference“ button we can search topics, program and deadlines to conference. If we want to sign to conference we need to register to the system and then by clicking the „Sign to conference“ button we confirm our interests in conference and we can choose our role for conference. If we choose role of organizer, other organizers or systems admin must confirm our role. If they reject this demand, we will get the role of author (Figure 5).

Figure 5 Set role to conference

The role of organizer can see all conferences organizated by him, can add or reject other organizers to his events and can also add and edit information about conference. Organizer creates the order form, sets billings information, inserts program, topics and deadlines, sets information for authors, inserts sponsors and their logos. The role of organizer is allowed to view all participants, their orders and papers added to conference (Figure 6). He can consider paper suitability to the conference and also can reject this paper. Also he can be an author to these or other conferences, so if he signs to the other conference, created by other organizer, he again chooses his role to this event.

View accepted articles

Open articles for authors and participants Close articles for authors and participants

S.N	Name	Title	Article	Status
1	Petra Pleskova	Article 1	Detail	Accepted
2	Petra Pleskova	Article2	Detail	Accepted

Figure 6 View accepted articles

The role of author can add paper to conference and create order (Figure 7).

Figure 7 Add articles

The role of participant can sign to conference and create order as shown in Figure 8.

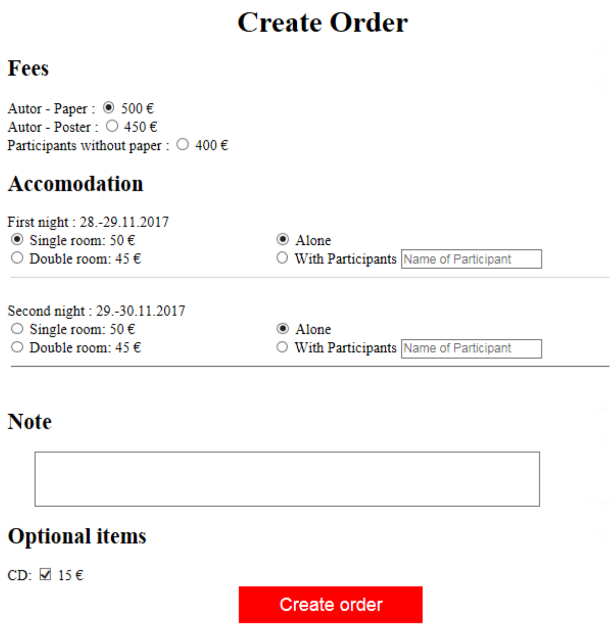

Figure 8 Creating order

Each user of *ConfUL* can change his role to all events. System administrator is the most important role in our system. This role is allowed to use every function of system. He can influence every activity of organizers and also has some special functions. The most important function of admin functions is to approve or reject new conferences.

Other functions are (Figure 9):
- creating new conferences,
- viewing all conferences,
- viewing requests for new conferences,
- viewing all users and view orders.

Figure 9 View all conferences here

5 Conclusion

The web conference system *ConfUL* represents a highly effective and useful tool for organization of conferences. It provides a very simple and user friendly interface for managing hundreds of information and financial flows between the participants of the conference. *ConfUL* allows users to organization, administration of submitted papers and orders, it provides information about conference to everybody online, in real time. This system makes organization simple, ordered and minimalizes the possibility of human factor failure.

The multicriterial analysis of other web conference systems enabled us to select the basic requirements of the information system. As shown in Figure 2 the common basic functions of web conference systems are registration and sign in of users, adding papers, creating orders and adding sponsors along with many more.

The *ConfUL* project includes more than one hundred subpages. Most of them are invisible for users but crucial for function of the system. The source code contains more than ten thousand rows of programming code and it took more than two years to build up.

The *ConfUL* system has got a big potential in developing its functions. We can easily adjust the existing functions and create many more allowing for more detailed organization of conferences. The system could thus become very effective tool for exchange of scientific information and could be used by many users from different institutions [6].

References

[1] BALOG, M., STRAKA, M.: *Logistické informačné systémy*, p. 208, EPOS, Bratislava, 2005. (Original in Slovak)
[2] *Základné pojmy informatiky*, [Online], [01.04.2017], Available: http://www.ssgke.sk/dokumenty/informatika/1_%20Z%C3%A1kladn%C3%A9%20pojmy%20informatiky.pdf, 2017. (Original in Slovak)
[3] JAŠKOVÁ, Ľ.: *Informačný systém – základné pojmy*, Univerzita Komenského v Bratislave, feb. 2015, [01.04.2017], Available: http://edi.fmph.uniba.sk/~jaskova/InformacneSystemy/tema02/tema02.html, 2015. (Original in Slovak)
[4] LEWKOWICZ, M.: *Information Systems*, Université de Technologie de Troyes, France, 2015.
[5] SKALKA, J. et al.: *Algoritmizácia a úvod do programovania*, p. 160, UKF Nitra, Nitra, 2007. (Original in Slovak)
[6] PLESKOVA, P.: *Projekt informačného systému pre potreby logistiky konferencií organizovaných ústavom logistiky*, p. 84, TUKE, Kosice, 2017. (Original in Slovak)

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THE DEVELOPMENT OF SELECTED INDUSTRIAL INDICATORS IN SLOVAKIA IN 2006-2016

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Keywords: mining industry, Slovakia, underground mining, surface mining, development
Abstract: The export industry belongs in Slovakia among industries that are at the start of the industrial chain. Its primary task is to provide raw materials for other industries [1].In the 1990s there was a decline in mining. The decline was mainly due to the drop in coal, ore and salt mining. As a result of the liquidation of the mines, the unemployment rate was rising rapidly. However, surface mining did not show a sharp decline. The aim of the article is to point out the development of the mining industry in Slovakia at present. The development of the mining sector in the years 2006-2016 was monitored by industry indicators such as the evolution of mining, sales, inflation rates, the number of employees, average nominal wages, and so on.

1 Introduction

The mining sector differs from other sectors in Slovakia by being fully privatized. According to Mining Act No 44/1998 Coll. on the protection and exploitation of mineral resources, minerals are divided into reserved and non-reserved. From a strategic point of view, raw materials are considered as the primary source of input for production processes, in this respect, they have an important position for the further development of the economy of the Slovak Republic. According to the article 4 of the Constitution of the Slovak Republic, the internal wealth of government-owned raw materials. The state owns exclusive deposits of mineral resources. Non-reserved minerals (eg building stone, gravel, and brick raw materials) are part of the land pursuant to § 7 of the Mining Act. The state, being the owner of exclusive deposits, creates, in accordance with valid legislation, the premises and conditions for business entities in their use [2].

The mineral resources of the Slovak Republic is non-renewable, so its constant protection and efficiency in exploitation are taken care of. This is due to a thorough analysis of domestic raw materials, which we have also focused on this article.

2 Analyses of the development of mineral resources in the Slovak Republic

In the Slovak Republic, mining companies use deposits of commercial minerals on the surface, in the underground, or the mining activity is carried out in a combined manner using the most suitable mining methods [3], [8]. Among the factors that influence the choice of the mining method are the mining and geological conditions deposits of minerals and their impact on the environment, the surrounding countryside and the nature surrounding the bearing [4]. In Slovakia, the most used deposits of energy raw materials are ores, building materials, gravel and sand, limestone, brick raw materials and other raw materials (perlite, bentonite, talc, etc.)

In the year 2016 942 mineral deposits were recorded, of which 564 were exclusive deposits and 378 deposits of non-reserved minerals.

Mining in Slovakia in the monitored period 2006 - 2016 has increased since the extraction of minerals on the surface since 2006, with the opposite trend being recorded in the mining of minerals in the underground. Figure 1. Mining has reached almost 40 million tonnes in 2016 (39 098, 9 kt), an increase of 2.33 mil. tons, such as the average for the last 4 years.

The extracted minerals from the underground were 2 761.35 kt in solid form in 2016. Thus, compared with 2015, there was a decrease in the mining of minerals from the underground by 187,111 kt. The decrease in underground mining is recorded in Figure 2 for the period 2006-2016 [3].

In 2016 a decrease was recorded also in surface mining, when a total of 36 337,55 kt of raw material was extracted, a drop of 3571,03 kt see Figure 3. Mining and processing of most non-metallic and building materials (magnesite, limestone, dolomite, gypsum, building stone and the like) cover a substantial amount of domestic consumption, which is of positive economic importance. Conversely, the extraction of fuel-energy and ore rawaterials, which is permanently covered by imports in Slovakia [3].

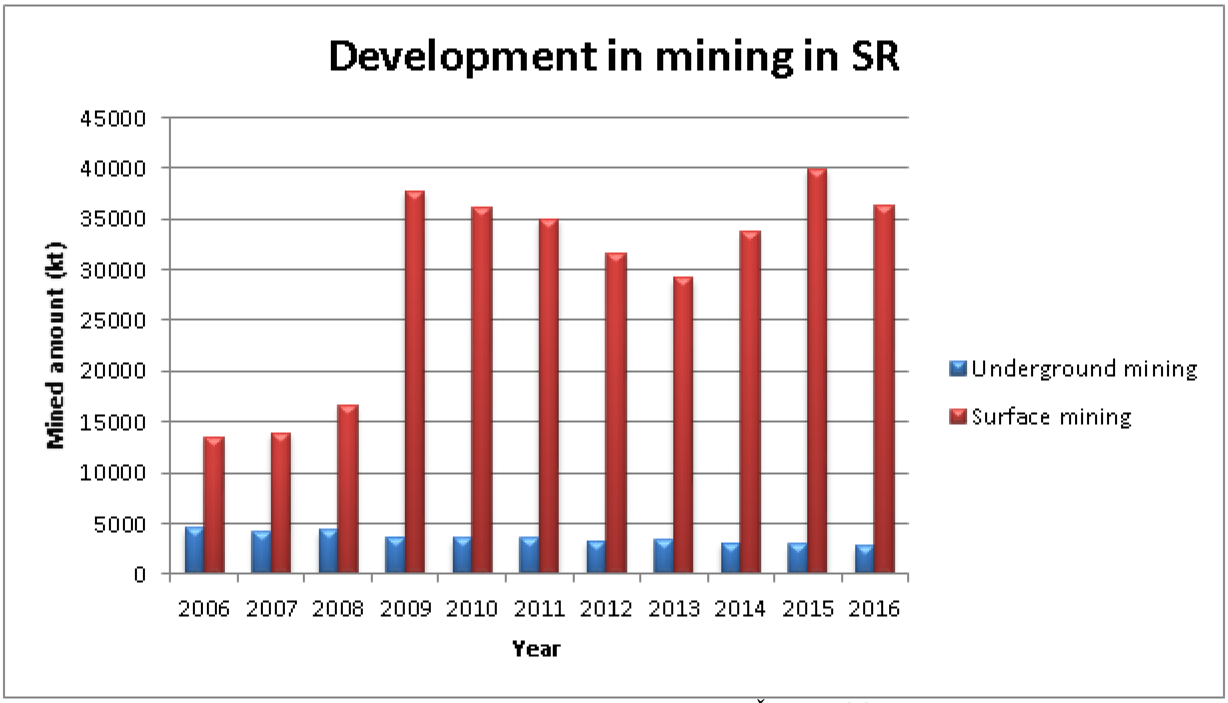

Figure 1 Development in mining in SR in reported period 2006-2016 Štatistický úrad SR, [Online], Available: http://www.statistics.sk/, [10 Dec. 2017]

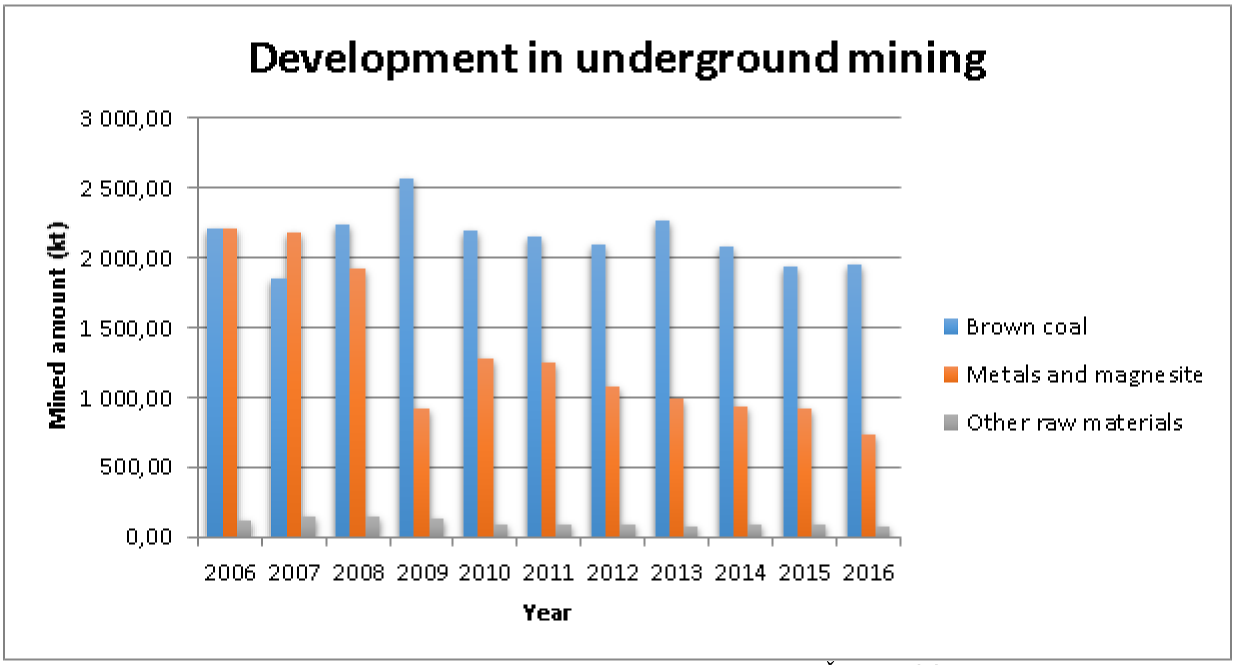

Figure 2 Development in underground mining in SR in reported period 2006-2016 Štatistický úrad SR, [Online], Available: http://www.statistics.sk/, [10 Dec. 2017]

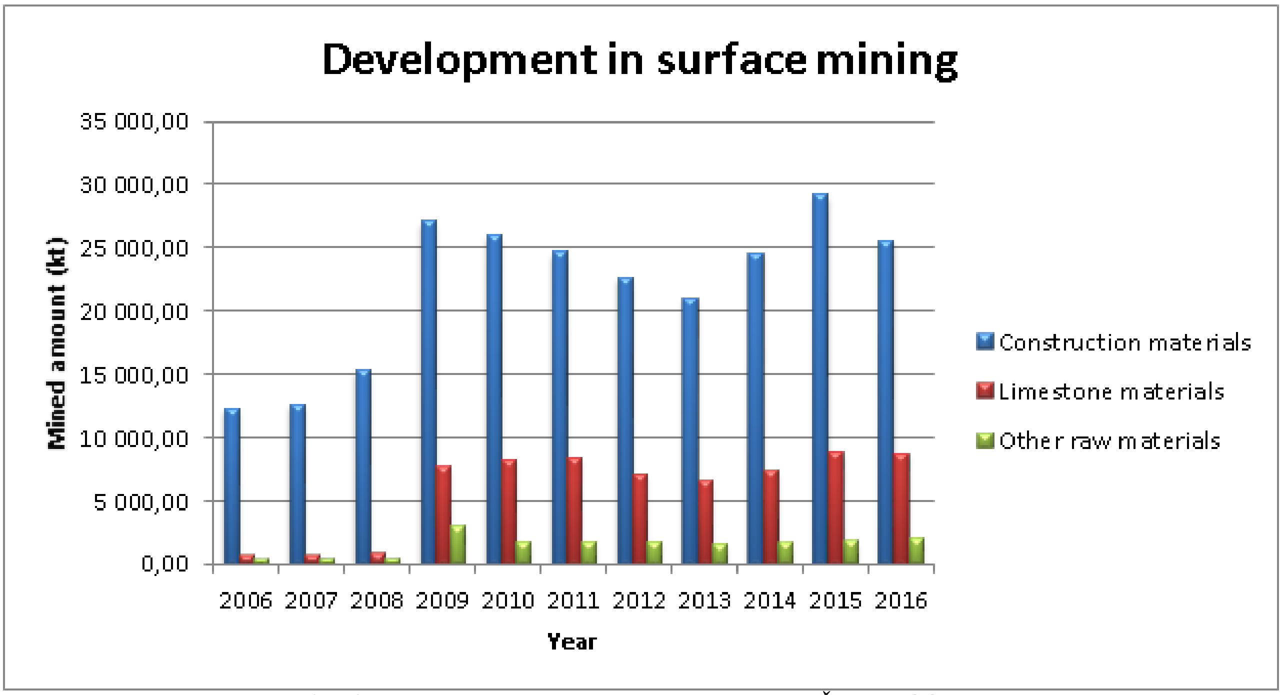

Figure 3 Development of surface mining in SR in reported period 2006-2016 Štatistický úrad SR, [Online], Available: http://www.statistics.sk/, [10 Dec. 2017]

In non-ore and construction raw materials, the increase in Figure 4 was recorded. In 2016, the share of ore mining in inventories amounted to 0.01%, for energy raw materials 0.17%, for construction materials 0.58% for non-manganese raw materials 0.08% [5].

In 2016, the geological reserves on exclusive deposits reached 18,790 mil. tonne with the main predominance of non-manufactures (14 795 million tonnes) (Figure 5). In the course of 2015, there was a slight increase in the extraction of non-metallic and construction raw materials. In the long run, there has been a clear decline in the extraction of ore and a decrease in the extraction of energy raw materials.

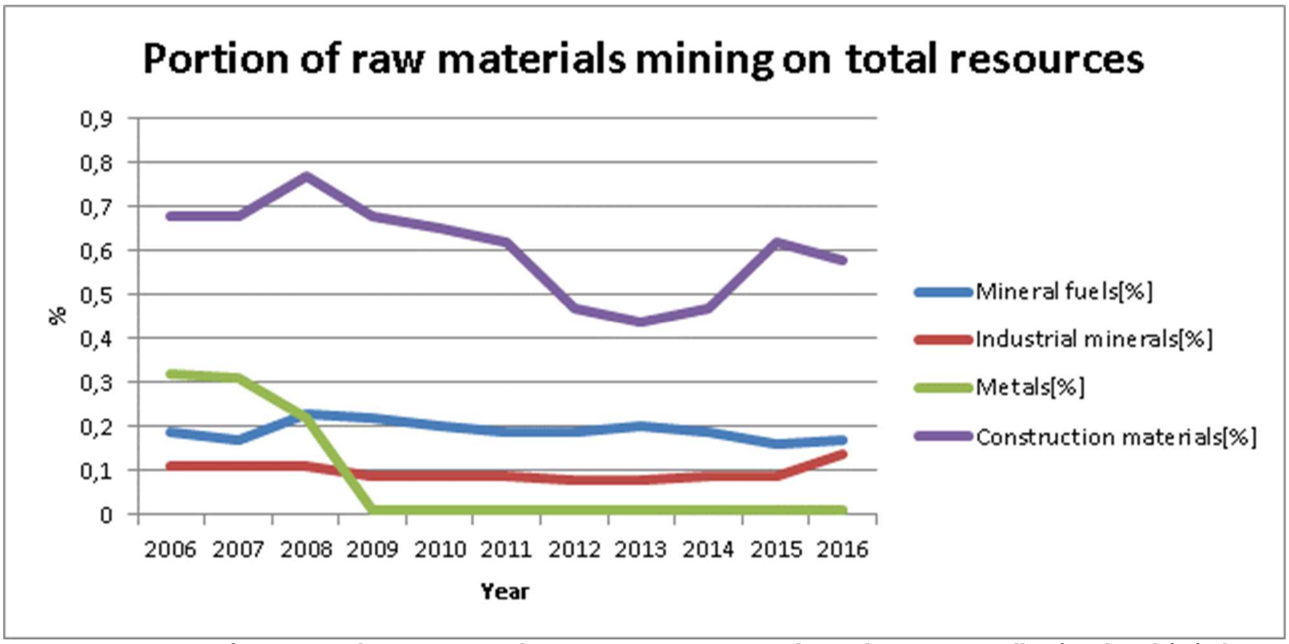

Figure 4 Portion of raw materials mining on total resources in SR in reported period 2006-2016 Celkové geologické zásoby nerastných surovín na výhradných ložiskách [Online], Available: https://www.enviroportal.sk/indicator/detail?id=181, [10 Dec. 2017]

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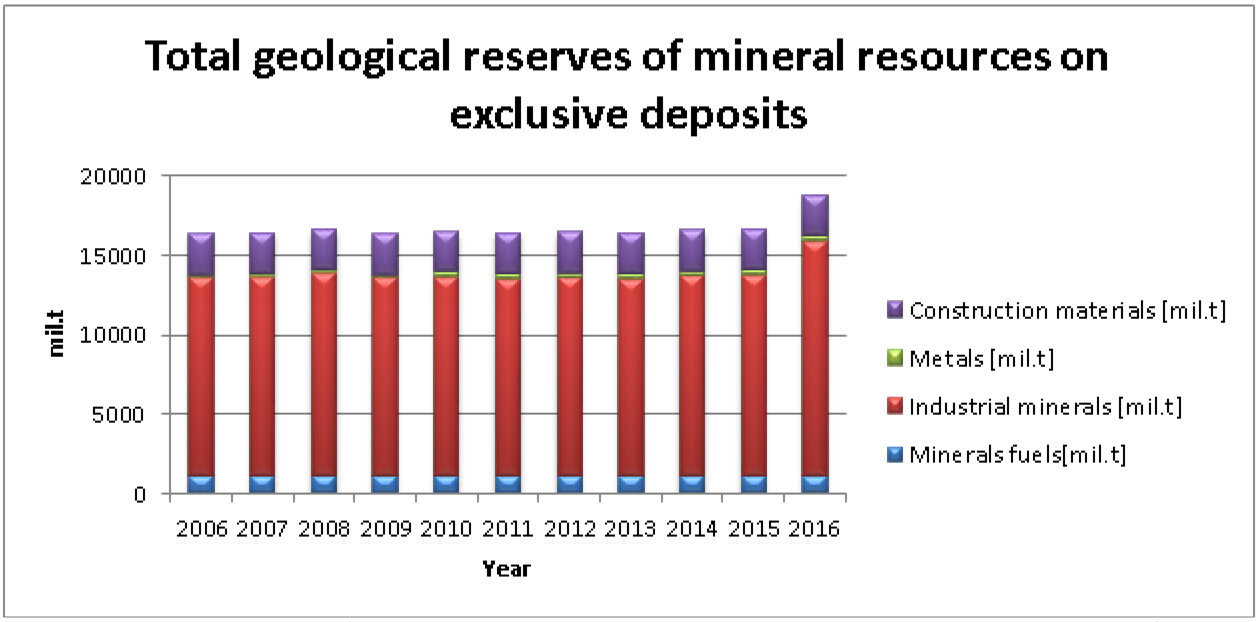

Figure 5 Total geological reserves of mineral resources on exclusive deposits in SR in reported area 2006-2016 Celkové geologické zásoby nerastných surovín na výhradných ložiskách [Online], Available: https://www.enviroportal.sk/indicator/detail?id=181, [10 Dec. 2017]

GDP in the mining industry

The export industry contributes very little to the GDP creation of the Slovak Republic, about 0.4% [6] (Table 1). It can be said that business in this sector is not particularly attractive due to the financial difficulty needed to start a business and the amount of necessary administrative equipment without which it is not possible to start not only the mining itself but also the geological survey of the mining area.

Production and sales in the mining industry

This trend can often be caused by a lack of investment needed to realize the exploitation. Therefore, also on the basis of that index and individual sales, it can be concluded that the large impact on the production of the mining company has an inflow of foreign direct investment that can help companies overcome the risk period. Lower revenues may be signs of increased competition between mining companies not only at home but also abroad (Figure 6). The world market is still entering businesses with similar products, which are lower, but often of lower quality.

Table 1 Development of production in the mining sector in SR in reported period 2006-2016 [7]

Mining												
Industrial Production Index Secure												
	Code SK NACE	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
romr = 100	5.9	-	-	-	101	99,8	98,7	96,9	99	102,9	100,4	96,9
average month of the year 2010 = 100	5.9	-	-	99,1	100,2	100	98,7	95,6	94,6	97,4	97,8	94,8

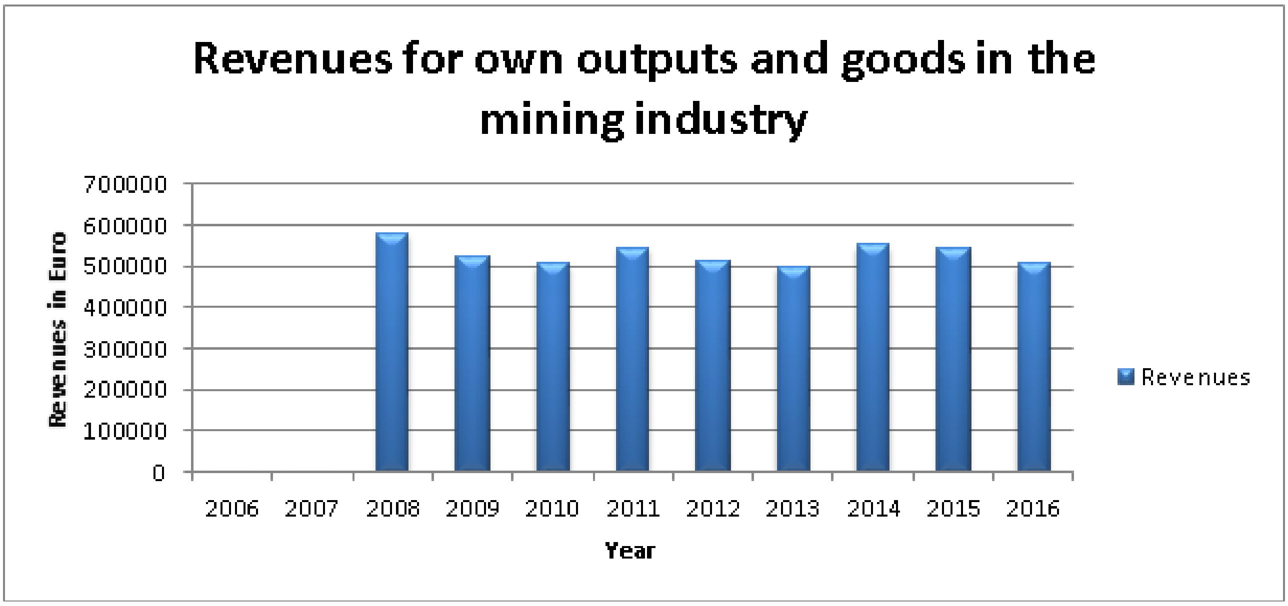

Figure 6 Development in revenues in mining sector in reported period 2006-2016 [7]

Inflation rate and annual growth of prices

The annual rate of inflation measured by the harmonized index of consumer prices reached a negative value of 0.5% in 2016. The price index of industrial products in the mining and quarrying sector is declining since 2014. Inflation in the last 5 years has been considerably rising but also declining. Figure 7 [7].

The rising cost of individual products may negatively affect the company's product sales. This, however, can be reduced by the increasing quality of the products. Therefore, there may not be any decline in sales as buyers make purchases not only for the price but also for the quality and specific features of the product.

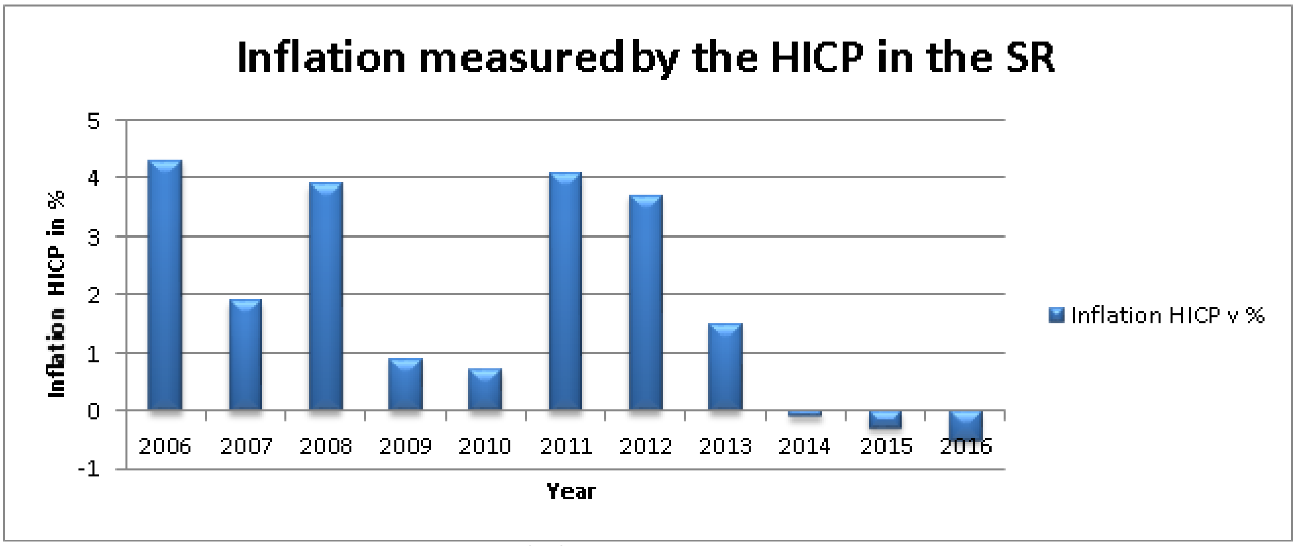

Figure 7 Development of inflation in SR in reported period 2006-2016 [7]

Number of employees and average monthly wage

According to the employee and average monthly wage figures (Figure 8, Figure 9), between 2006 and 2016, it can be concluded that the average monthly wage increased with a lower number of employees [7]. Again, this perception may be misleading because the average monthly wage was not affected by the decreasing number of employees, but rather by the increasing average wage in the Slovak Republic. The gradual reduction in the number of employees may be due to a potential downturn in mining or, rather, the replacement of the labor force with newer technologies.

Based on the amount of average monthly salary in the mining industry, it can be obvious that for workers, the work in the mining industry is an attractive offer. An advantage for mining companies is to earn higher wages, but the disadvantage is the inability to employ a larger number of employees.

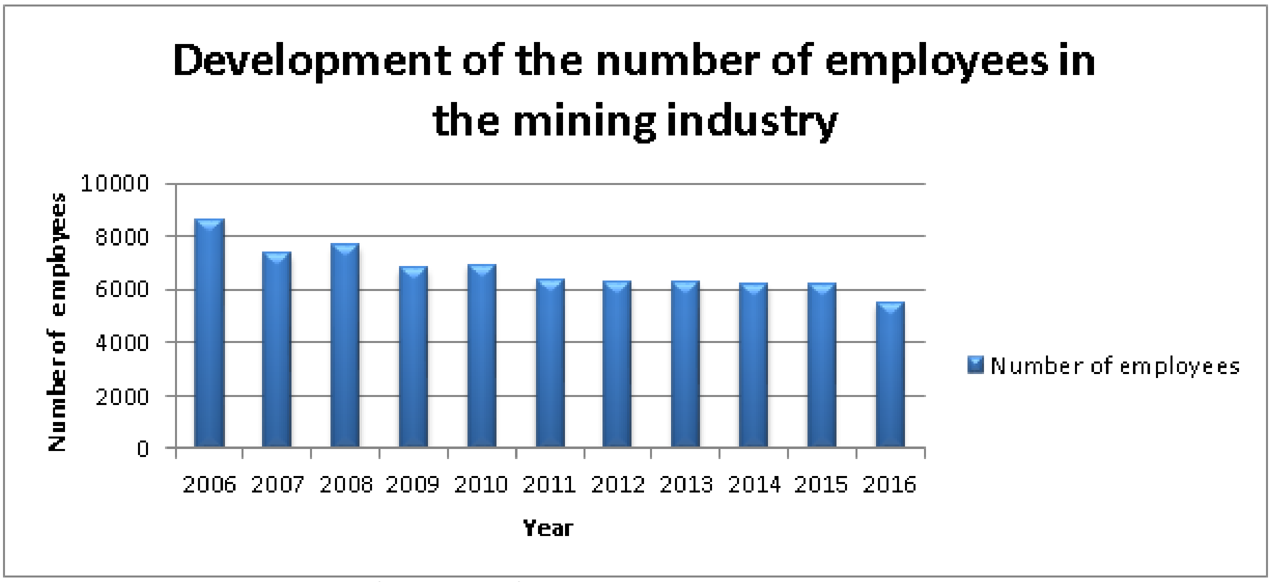

Figure 8 Development of the number of employees in the mining industry in reported period 2006-2016

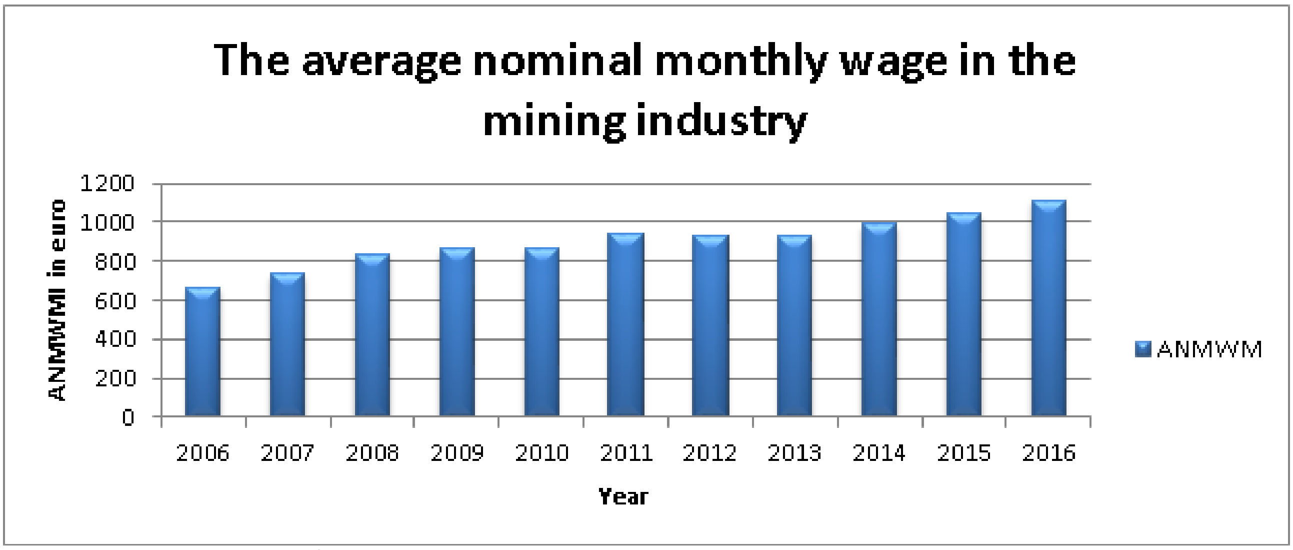

Figure 9 Development of The average nominal monthly wage in the mining industry in reported period 2006-2016 [7]

Conclusions

An analysis of the development of mining in the monitored period 2006-2016 shows that there is still a decline in mining activity. The attenuation of the mining activity is influenced by several factors. These include the effects of the economic crisis in Slovakia and the world, as well as a gradual increase in input prices in the mining and mining activities. The consequence of this negative economic and economic situation is the gradual liquidation of mining operations. This negative impact negatively affects not only the very low share of the extractive industry itself on GDP but also the social situation of employees in mining organizations. Indicators that show a favorable development include improving the quality of the environment, especially in the vicinity of former mining organizations. One way to achieve good environmental protection is to tighten up the criteria for assessing environmental impacts already when permitting mining or mining activities.

References

[1] CHOVANCOVÁ, J., ADAMIŠIN, P.: Environmentálne aspekty procesov a technológií, Univerzitná knižnica Prešovskej univerzity v Prešove, PULIB, 2016. (Original in Slovak)

[2] Zákon č. 44/1988 o ochrane a využití nerastného bohatsva, [Online], Available: http://www.zakonyprel udi.sk/, [29 Jan. 2018], 2018. (Original in Slovak)
[3] Bansko-hospodársky vývoj. Správa o činnosti HBÚ a OBÚ v SR za rok 2016. Hlavný Banský úrad v Banskej Štiavnici. [Online], Available: http://www.hbu.sk/sk/ Vyrocna-a-rocna-sprava/Rocne-spravy.alej, [29 Jan. 2018], 2016. (Original in Slovak)
[4] Cehlár, M., Engel, J., Mihok, J., Rybár, R.: Povrchové dobývanie, Edičné stredisko/AMS, F BERG, TU v Košiciach, Košice 2005. (Original in Slovak)
[5] Celkové geologické zásoby nerastných surovín na výhradných ložiskách [Online], Available: https://www.enviroportal.sk/indicator/detail?id=181, [10 Dec. 2017], 2017. (Original in Slovak)
[6] Podnikanie a zamestnanie na Slovensku. Ekonomické prostredie. Komapol s.r.o., Bratislava 2010. AE press, 2010. (Original in Slovak)
[7] Štatistický úrad SR, [Online], Available: http://www.statistics.sk/, [10 Dec. 2017], 2017. (Original in Slovak)
[8] Banská komora, Baníctvo bolo a vždy bude, [Online], Available: http://www.banskakomora.sk/archiv/47-banictvo-bolo-a-vzdy-bude, [10 Dec. 2017], 2017. (Original in Slovak)
[9] Puzder M., Sijarto J.: Resources policy and valuation deposits in Slovakia, 2015. In: International Forum-Contest of Young Researchers. - St. Petersburg, Russia: Mining University St. Petersburg, 2015, p. 215-216, 2015.

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OPTIMIZATION OF MATERIAL FLOW BY SIMULATION METHODS

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Keywords: simulation, logistics, material flow, KANBAN, loss
Abstract: In the sphere of production area, methods of simulation of production processes and logistic processes are increasingly used. These methods are mainly used in planning, optimization and operational management of production flows and technologies.Material flow simulation methods are closely linked to information technologies and related statistical disciplines. The combination of these disciplines allows the creation of efficient methodologies for generating material flow through simulation models and related algorithms. Logistic dependencies found through these models are then ideally applicable to serial production lines.

1. Introduction

Based on the above-mentioned findings, it is a cyclical process that brings new scientific knowledge and concepts that enable the implementation of a systemic approach to the solution of logistics problems, new technologies and processes in manufacturing area due to emerging automation and management technologies and actually brings with it new challenges in the field of theoretical research. An important contribution in this area is the effort of many companies to gradually create the basics of management on the 4.0 industry platform. At the early stages of preparation for this business management concept, manufacturing processes focus on integrated product development, production planning, logistics concept and production system layout with a view to minimizing waste times in material flow and operations. All these steps must be targeted and matched by the corresponding strategical processes. One of the tools to recognize company processes as a living organism is to use visualization and simulation of strategic company processes with a focus on continuous enterprise data management [1]. Visualization and simulation are recommended to use because of the overall complexity of data, which can not be easily described using a classical mathematical methods. Instead of an analytical approach is used computer technology to create a digital model of a real system. A simplified display of an existing system, including downstream processes, is considered a model. Modeling is used to simulate the behavior of the real system. We are talking about the simulation model. Through the simulation model, we perform simulation experiments to test the response and behavior of the system, depending on the impulses given. Simulation experiments are based on simulation tools that can be combined with artificial intelligence using the Petri nets, neuron-networks, the concept of building elements, etc. The simulation models can also be used for the virtual implementation of production lines, robotic workplaces, handling elements. The aim is to connect all available information (production documentation, orders, inspection certificates) to database in order to achieve synergy with material flows in the enterprise.

2. Principles of Material Flow Modeling

Material flow is understood as the movement of components in a complete manufacturing process from input of raw materials through semifinished products to final product and dispatch to the customer [2]. An integral part of the material flow is a set of activities and data closely related with a material flow. We call the set of these activities a logistic chain. Activities closely tied to material flow can proceed simultaneously with the material flow, they can follow material flow, or even against the material flow. In many cases, the production stream is monitored separately from the material flow. That is why was created the concept of logistics. From the point of view of strategic management, we consider logistics a set of activities leading to the acquisition, manipulation and storage of input materials, semi-finished products and finished products. The aim is to maximize the profitability of individual orders. These activities form a unified system, which is defined as a set of things and relations between them interconnected in one complex enitity. For definition of system, we then use logic schemes, math and natural language (1), therefore:

$$\text{System} = (Q/F/R/P) \qquad (1)$$

where:
Q – set of system elements and **F** is a set of functions
Q/F – set of functions of each system element
R – a set of relations and a **P** set of system elements
R/P - a set of relationships between system elements

The system is also defined by inputs and outputs on its interface. In the system then follows to sequence of states depending on the actual state of the system. The sequence of these states is called a process. The set of processes is then defined as behavior [3]. Complex material flow can be observed especially in series production. Reliability of this system is judged on the basis of reliability theory according to level of automation, manual workplaces, complexity of production operations planning in production process. The basic criterion for assessment of material flow is the distribution of material flow from a time view. We distinguish the discrete and continouos flow. As discrete flow, we consider the transfer of individual entities. As continuous material flow is considered distribution of the medium (compressed air, natural gas, etc.). In the material flow simulation, we deal with a discrete material flow, where we evaluate the movement of individual entities over a defined path at defined time intervals. In order to view the material flow thus defined, we use flowcharts that allow to visualize the desired level of differentiation - movement, waiting, branching, connection, etc.

3. Significant material flow characteristics

We assume a discrete material flow between two sites (*A - source location, B - output station*) on the ***l*** path. The number of through-entities is subsequently defined with respect to the possibility of determining average daily production [*ks.hod*$^{-1}$]. Most simulation studies have the following characteristics:

Throughput λ [*ks·s*$^{-1}$] (2) is determined by the intensity of the inputs and the velocities of the material movement ***v***. If we measure the transport of material on a conveyor with a defined free space of two entities ***s***, the throughput will be given by:

$$\lambda = v/s \tag{2}$$

We can reach the maximum values (3) in the theoretical case when the distance between individual entities is zero.

$$\lambda_{MAX} = v/s_0 \tag{3}$$

These simple relationships will be used in simulation models, assuming a constant speed of material movement on a given path. The extent to which the maximum (as is apparent from the theoretical results) of the throughput is reached, is defined, in accordance with the above equation (4), by the ratio:

$$\rho = \lambda/\lambda_{MAX} \leq 1 \tag{4}$$

If time intervals between discrete values get discrete values, it means *v = const.* and *s = const.* the time between passes can be understood as a random value with a defined probability density and distribution function (5):

$$0 \leq f(t) \leq \infty \rightarrow F(t_K) = \int_0^{tk} f(t)dt \tag{5}$$

Practically, we consider the time between passes (6):

$$E(t) = \int_0^{\infty} f(t) \tag{6}$$

This methodology can be applied in any logistic chain. In each logistic chain can delays occur when the material does not move. These delays can have divided as followed - planned delays or as unplanned delays and may be caused by necessary technological times between operations, appearance of non-conformity products in production process, machine breakdowns, etc.

Optimization of this downtime is dealt by Applied Mathematics in Queueing Theory, which uses stochastic models working with individual elements in the system at two levels. Analytical level using known model parameters using probability theory tools and simulation level, which is based on the estimated model parameters simulated behavior of the system [4].

4. KANBAN method flow management

The KANBAN circuit can be considered as a self-regulating control circuit based on the defined type and number of KANBAN cards. A typical feature of this circuit is one station between the supply and customer workstations. A simple KANBAN circuit is represented by the following material and information flow (Figure 1).

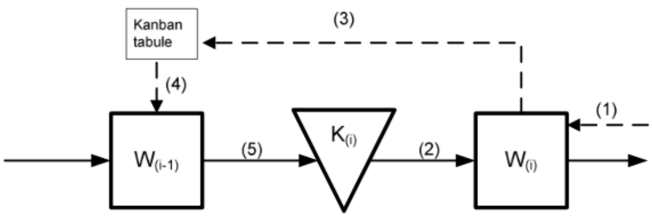

Figure 1 KANBAN circuit, material and information flows

The principle is follows: At the *W(i)* workplace, comes a request from higher-level about the delivery of the product. Components from the KANBAN container *K(i)* are used to meet this requirement, then a card is moved to the workplace *W(i-1)*. This is the impulse for starting the production of the required material in the quantity defined on the KANBAN card. After finishing production on the *W(i-1)* workplace, the card is placed in the KANBAN position *K(i)* and waits for next process at the workplace *W(i)*.

The dual KANBAN circuit (Figure 2) is used in the case of limited storage capacity and increased demand for material flow optimization within the production process and individual operations. The dual KANBAN circuit uses multiple storage space in the supply of individual workplaces to ensure timely optimization of customer supply in the chain and minimization of unused supplies [5]. As part of our material flow simulation, we take advantage of electronic KANBAN with the support of company information system. Electronic KANBAN uses the data and IT infrastructure of the enterprise information system. For information transfer is used the advantages of information technology are utilized to make the classical

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dual KANBAN combine into one comprehensive electronic KANBAN system, including both the transport and production KANBAN circuits. The advantage of an electronic KANBAN system is the ability to generate requests directly from the corporate IS as shown in the following diagram.

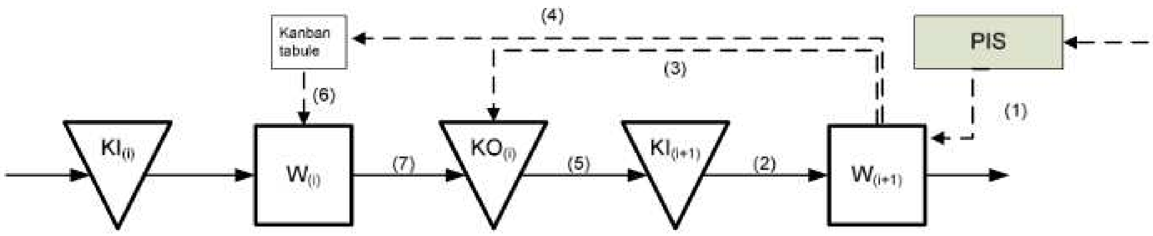

Figure 2 The dual KANBAN circuit

Numbers of KANBAN card for outside circuit is count as follows (7):

$$M = \{DL\ (1+a)\ \} / d \qquad (7)$$

where:

D – Demand for an average consumption of parts per time unit

L - Lead time required to deliver parts from order

a – safety coefficient

d – amoount of pieces for individual KANBAN card.

L - is calculated (8), from the above image, as the sum of the times from ordering the material (sending) from the customer´s KANBAN card

$$L = t5 + t6 + t7 + t4 + t2 \qquad (8)$$

where:

t5 is approaching zero in electronic KANBAN because the transmission of an electronic KANBAN card by the information system is immediate.

t6 is the time to classification a KANBAN card on a KANBAN board from the production of the material at the supplier's workplace.

t4 is the time required to move the material between the delivery station of the supplier's workplace and the customer's input station.

t2 and *t7* are times needed to deliver material from the workstation to the KANBAN station. From information mentioned above:

$$L = t_6 + t_4 \qquad (9)$$

then:

$$M = \{D.(t_6 + t_4)\ .\ (1 + a)\} / d \qquad (10)$$

From the meaning above (9,10) is obvious that the basic requirement of the organization following the implementation of the KANBAN method is to optimize material flow in terms of cost and time waste in the form of surplus stocks. Based on the acquisition of relevant data on the use of KANBAN implementation, it is necessary to measure the performance of this method. Performance parameters are determined by parameters that will be compared to each other. In this case, it is the cost of inventories in circulation, which are a reliable indicator for assessing the material flow economy. Another parameter is the stock turnover. Both of these parameters are directly proportional to the amount of inventory. As inversely proportional to the cost of inventory, we estimate the cost of transporting the material, or the cost of insufficient material within the KANBAN circuit (Figure 3). There is a dependence between both parameters, which can be expressed as the sum of these costs. At the minimum point of this function, we find the optimum amount of inventory, the point where the total cost of inventory is the lowest.

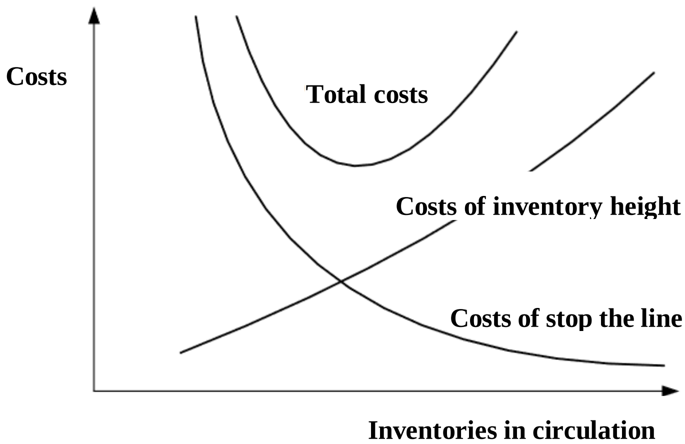

Figure 3 The chart of costs insufficient with the KANBAN circuit

5. Conclusion

From the view of customers and still increasing requirements on quality, delivery dates and final product prices, it is necessary to address the possibilities of optimizing the production process and search weaknesses in this process, in order to complexly increase the efficiency of the company's operation. It has to be done together with the search for weaknesses, which increase the cost of production and negatively affect the production process in terms of cost, quality and overall logistics. Together with the development of automation and artificial intelligence, it is essential for businesses to start analyzing existing processes to further automate and develop these processes. An integral part of this process is the strategy of further development of the company due to the development of our own product and new technologies. This step must be preceded by a perfect mastery and understanding of ongoing business processes. The ability to simulate production processes in an enterprise can provide relevant information about the further development of the process and the optimum material flow. This is supported by company information technology and appropriate technical equipment for data collection. Simulation and subsequent optimization of production processes for companies that want to succeed in global competition must become an integral part of corporate technology, even with regard to the relatively short return on investment associated with a competitive advantage that increases the chances in the global market.

References

[1] PERICA, P.: *Logistický management, Teorie a podniková praxe*, Radix, s.r.o., Prague, 1998. (Original in Czech)
[2] PRECLÍK, V.: *Průmyslová logistika*, Vydavatelství ČVUT, Prague, 2006. (Original in Czech)
[3] KUNCOVÁ, M., MEDONOS, M., DLOUHÝ, M.: *Využití simulačních modelů k analýze výrobního procesu*, Technická univerzita v Liberci, Liberec, 2010. (Original in Czech)
[4] WILSON, L.: *How to implement Lean Manufacturing*, McGrawHill Professional, 2009.
[5] WANG, J.: *Lean Manufacturing: Business Bottom-Line Based*, CRC Press, 2010.

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