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# ALTERNATIVE APPROACH TO DETERMINING THE INNOVATIVE OBSOLESCENCE OF INDUSTRIAL PRODUCTS

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**Abstract:** *Technological development, nowadays, has entered a crucial stage that gives precedence to the innovative obsolescence over the physical one. To that effect, of utmost importance, therefore, is the accurate identification of the extent, i.e. the degree of innovative obsolescence in an effort to assess the effect of innovation upon the technical-economic performance and social outcomes of the industrial activity. Moreover, in an increasingly globalizing economy, innovations are bound to make a worldwide impact, accelerating the innovative technological obsolescence with the level of technology being utilised is globally lagging further behind the level of today's technology. Prolonged use of obsolete technology and outdated technological processes leads to certain losses, the amount of which is contingent on the extent of the lag range. Advanced in the paper is an alternative approach to determining innovative obsolescence of technological products and the respective solutions in pursuit of a marked reduction in its adverse effects.*

**Key words:** INNOVATIONS, INNOVATIVE OBSOLESCENCE, INNOVATION STRATEGIES

## 1. Innovative obsolescence

Innovative obsolescence refers to the underperformance of the currently utilized equipment and technology which is reported to fall well behind the level of recently developed innovative machinery and technology. Accordingly, they become less capable of competing successfully which inevitably results in certain losses.

Innovative obsolescence imposes certain conditions the companies should comply with. This stems from the attitudes towards technology and is significantly influenced by the active consumer interest in new products [3,4,5]. This is the reason why more and more companies have started to apply flexible technological and organisational patterns of behaviour to react to the surrounding industrial and market world in a proper way, namely:

- build their vision of a market and competition on the basis of the innovative development of modern industry on a global scale;
- adjust their own innovation policy to the overall industrial policy throughout the world;
- implement alternative methods and strategies to reduce the adverse effects of rapid innovation obsolescence.
- strive for the solution of high-tech problems and the production of products highly saturated in terms of innovation;
- apply flexible technological forms of production;
- coordinate their activities with flexible information technology;
- adapt to the market through flexible forms of production and product realization;
- confine their production to the area or locality where it is most profitable and where the effect of implementing innovative solutions is greatest.

In essence, this means that a global innovation policy is emerging, the manifestation of which is beginning to assume flexible technological and organizational forms in specific enterprises. This is a policy that readily adapts to the global industrial behaviour of innovations as a resource for their future development.

## 2. Determining the degree of innovative obsolescence of industrial products

Innovative obsolescence is measured by the degree of depreciation of any of the functions of the old machinery structures, facilities, etc. compared to those of newly produced innovative ones. They are determined in the following sequence, using the formula:

$$M = W.K \tag{1}$$

where:

M –innovative obsolescence, (devolution of the functions of older machinery) (BGN);

W – initial value of the old machine (BGN);

K – Coefficient that expresses the level (%) of innovative obsolescence ( $0 < K < 1$ ).

K - in the range  $0 < K < 1$ , where:

With  $K = 1,0$  there is no innovative obsolescence (the machine is 100% innovative).

With  $K = 0,5$  the machine is half-way innovatively outdated or 50%.

With  $K = 0,0$  the machine is fully innovatively obsolete or 0% innovation.

K - defines innovation only within the range of 0 to 1.

$$K = (1 - E) \tag{2}$$

where:

E – the degree of innovation of the machine at a given time (at the time of measurement).

### Degree of innovation

The degree of innovation (E) determines how much a machine is innovative (%) as compared to the reference machine. It is calculated as follows:

$$E = \frac{D_1}{D_2} \tag{3}$$

where:

$D_1$  – the ratio of the value of the new machine to the value of the old one.

$$\text{Or } D_1 = \frac{V_1}{V_2} \tag{4}$$

where:

$V_2$ - value of the new machine.

$V_1$ - value of the old machine.

$D_2$  – the performance ratio of the new machine to the productivity of the older one.

$$\text{Or } D_2 = \frac{Q_2}{Q_1} \tag{5}$$

where:

$Q_2$ - productivity of the new (innovative) machine.

$Q_1$ - productivity of the older machine.

Substitute and get the lines: 
$$K = 1 - \frac{D_1}{D_2} \tag{6}$$

**Further clarification and explanation** to the main indicators outlined above;

1.The relation 
$$\frac{D_1}{D_2}$$

- should be positive (+), to indicate that;

A) There is innovation, or that the degree of innovation of the machine is growing.

B) With negative relation (-) the conclusion is that the innovation of the machine is reduced or the machine is not innovative.

In short, this means that  $D_2$  should have precedence over  $D_1$  or the price of the new machine should be in an optimal relation with the

price of the older machine. As for the performance of the new machine, it should always be higher than the performance of the older machine.

3. Determining the length of the operational (service life) period of the types of machine structures as:

- Conventional or Class A, these are the traditional machines and Class A1, these are machines where the indicators reliability/warranty period/service life are the same at each time.
- Mechatronics (Modular principle). They have an optimal relation of reliability/warranty period/service life.
- Cyber-system machinery.

4. The relation  $(1 - E)$  can be to the  $n$ -th degree when we follow the development of the innovation process in case of innovations with global degree of novelty.

$n$  – just another consecutive innovation against which it is measured (serves as reference base).

$h$  – scale factor ( from 0,5 to 1,00) Range of manifestation.

$h=1$  , when  $n=1$  , then, it refers only to technologies with global degree of novelty.

$h=0,5$ , when  $n=0,5$  , then, it refers only to innovations with regional scale of the impact of innovation implementation.

Then:

$$K = (1 - E); \tag{7}$$

$$E = \frac{D_1}{D_2} \tag{8}$$

### 3. Alternatives to rapid innovative obsolescence of products and processes

The main directions ensuring an effective way out of the constraints imposed by the rapid innovative obsolescence in the creation of competitive innovative products are being actively applied by a number of companies in the automotive industry and electronics. This new approach, readily adopted by industrial companies, offers a clear advantage in the following directions:

- application of the modular principle of construction and production of innovative products;
- design and production of modules with a different technological purposes;
- design and production of innovative products with the highest possible reliability and short service lifetime;
- considering the design and production cycle as a continuous process of occurrence and employment of methods of competitive engineering, simulation, virtual representation, etc. with the aim of shortening the cycle as much as possible;
- the shortest possible cycle from conception of a given idea to the production of innovative product.

The swift innovative obsolescence of products and services poses to humanity the issue of addressing and coming up with feasible solutions to the problem of eliminating the harmful effects of its profound impact [1,2,8,9]. This is particularly imperative when issuing protective documents, such as patents, where the deadline/time limit for their issuance takes longer than that for the emergence of a new innovative solution. Alternatively, the innovative product innovatively obsolescent even before it has entered into operation. With the current development of computer and information technology this problem can be solved with the creation of a European or Global information centre with open access to the database. Patents should be granted only for those products and technologies that have a proven long-term innovation lives. As for all other inventions, a fee-based open access shall be provided to them [6,7,10].

#### Innovative development of companies

Innovative development and innovative obsolescence can also be viewed as a process of solving problems or shaping the company's innovation policy. Every problem-solving process begins with specifying and identifying the main problem or framing the company's innovation policy. If the problem is precisely and clearly defined, it can be formulated and presented clearly, that is, the company has an effective policy.

Innovative development as a problem-solving process can be presented graphically as shown in Fig. 1.

Basically, innovative development and innovative obsolescence refer also to the company's policy as part of its corporate policy and is an integral part of the overall technique-economic development of the company itself.

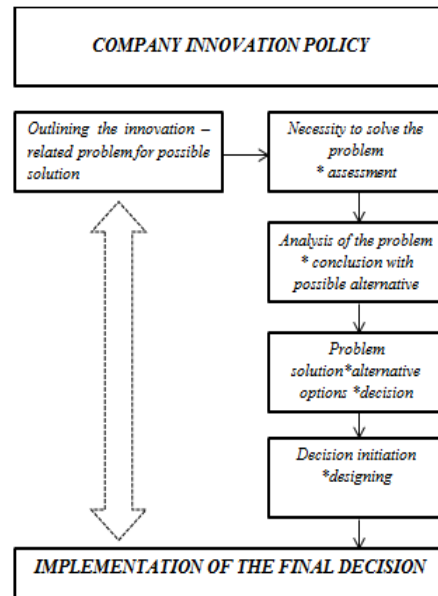


Fig.1. Innovative development

The strategic policy of the industrial company is inconceivable without a well-established, well-judged (i.e. correctly estimated) and well-designed innovation development policy making adequate provisions for the imminent innovative obsolescence as the main factor for the development. Innovation policy is believed to form the very concept of the economic performance indicators of the company and is a key factor for its prosperity.

#### Global trends in innovation development

The immediate technological progress and fast-track development has enormous impact on core activities such as energy, communications, biotechnology, nanotechnology, etc. It follows, therefore, that the biggest innovation boom will be expected in these areas. In principle, this is also associated with sharp development of innovative activities related to the servicing and maintenance of major priority axes in accelerating progress around the world. The complete attention of scientists worldwide will be directed to innovative development of: information technologies; biotechnology, creating and using new materials, nanotechnologies, alternative energy sources, space resource exploration and utilization, environmental protection.

#### Conclusion

In closing it can be concluded that innovative development and innovative obsolescence are interconnected manifestations of one and the same process. Furthermore, innovative obsolescence is open to close examination, harnessed and kept under proper control. To that effect, advanced in the paper is a new approach and alternative method for determining the magnitude and calculating the degree of innovative obsolescence of products and processes. Proposed is a set of tools for practical utilization and deployment.

#### Bibliography:

1. Damyanov D. Innovations, Primax, Russe, 2013.
2. Koleva, N. (2018), Methodology for studying the degree of development of the digitisation of production in Bulgarian industrial enterprises, participation in the 16th International Scientific Conference "Management and Engineering"18", 24-27 June, Sozopol, ISSN 1310-3946
3. Demirova S., Basic Indicators Forming Effectiveness In Developing Product Innovations, GE-International Journal of Management Research, Vol.5, Issue 5, May 2017

4. Demirova S., Innovative obsolescence and its impact on production development of industrial products, International scientific journal "Innovation", Year VI, ISSUE 1/2018, pp.7-9
5. Demirova S., A continuous joint cycle of designing and manufacturing industrial products as an alternative to their rapid innovation aging, SEPIKE CLOUD, 2017, pp.112-115
6. Tomov P., Increasing the Efficiency of Automation of Production Processes by Reporting the Parameters of the Parts' Flow.TEM Journal, 2017, 6(3), p. 484-487
7. Nikolov B., Tcholakova V., Aspects of risk management in logistics activities of enterprises. application of fault tree analysis (fta), Innovations in discrete productions, Year III, 2/2015
8. Nikolov B., Managing Reliability and Technogenic Risk in Manufacturing and Operating Systems, King's Institute, 2016, ISSN 978-954-9518-87-0
9. Nikolov B., Rethinking Risk Management - A Guide to Complex Risk Management, Scientific Journal of Industrial Management, year 9, issue 1, TU-Sofia, SF, ISSN 1312-3793, (2012)
10. Nikolova.I., (2018) Development and Application of Systems for Resource Planning ERP/ASP. Innovations in Discrete Productions, Issue 1/2018, Sofia, ISSN 1314-8907, pp.15-17
11. Tomov P., Possibilities for Implementing Production "Automation Islands" in an Automatic Production System, International Conference on High Technology for Sustainable Development, HiTech 2018 – Proceedings, Publisher: Institute of Electrical and Electronics Engineers Inc. ISBN: 978-153867039-2, DOI: 10.1109/HiTech.2018.8566356
12. Tomov P., "Innovative solutions for the automation of discrete production engineering" 12th International conference on "standardization, prototypes and quality: a means of balkan countries' collaboration", Kocaeli from 22nd to 24th of October 2015

# POSSIBILITIES AND RESTRICTIONS IN FORMING AND DEVELOPMENT OF THE INNOVATIVE POTENTIAL OF THE ENTERPRISES IN BULGARIA

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**Abstract:** *The realization of technological transfer and forming of innovative potential of the enterprises is of great significance for their development and progress in the dynamic modern business environment.*

*The purpose of the present article is to show some possibilities and restrictions related to the realization of the technological transfer, forming and development of the innovative potential of the enterprises in Bulgaria. Some basic trends are emphasized related to the realization of the technological transfer, forming and development of the innovative potential of the enterprises in Bulgaria.*

**KEYWORDS:** INNOVATIVE POTENTIAL, TECHNOLOGICAL TRANSFER, INNOVATIONS

## 1. Introduction

The demand and finding of new resources of growth for the enterprises is the basis of high and growing necessity of response to the dynamics and the indefiniteness of the business environment. The managers' challenges in this environment get such dimensions that sometimes is even difficult to divide and prioritize them. Undoubtedly one of the most important among them is implementing and developing effective politics in the field of innovations.

Despite that, the main part of the efforts in this direction needs to be focused towards development of Small and Medium-Sized Enterprises (SME). They are a main factor for the country economics, its growth and competitive power, for forming and development, as well as the continuous improvement of the infrastructures for innovations and technological transfer.

## 2. Exposition

The struggle for growth and competitive power of the enterprises has always been at one of the first places. Nowadays it is even stronger and it is one of the most important and significant questions that are seeking answers.

The development of the new generations of technologies including the invasion of digit technologies, the growing digitalization and forming of digital environment leads to new challenges for the enterprises as well as new possibilities [7, 14, 18, 19, 21].

In this environment the innovative potential of the enterprises can be defined as a main power of development [3, 4, 6, 20]. As a result of it the increasing of the economical indexes in the countries' economics that have enterprises with high innovative potential is a fact. This defines the main role and respectively the merit of the innovations especially

organizational and marketing innovations in 2010, are 31,1% from the Bulgarian industry, including sectors B, C, D and E, and the enterprises with technological innovations including the enterprises with product innovation, with process innovations and the enterprises with uncompleted and discontinued innovative activity are 22,3%. In the service sector, including H and K, and sections 46, 58, 61, 62, 63 and 71, the innovative enterprises are 22% and the enterprises with technological innovations are 11,9%.

The quotation from NSI presented on 29.06.2018 shows the following [8]: The innovative enterprises including the enterprises with technological innovations are 31,6 and the enterprises with technological innovations including the enterprises with product and process innovations are 24,9% (no matter if they have organizational or marketing innovations).

nowadays in the constantly changing characteristics of the business environment.

The possibilities of development of the innovative potential of the enterprises are connected and they depend on many factors. First – creating suitable conditions on the one hand and second – on the other hand – once these conditions are created they need to be adequately used, third – at what extent the built and existing structures contribute for their adequate usage and fourth – at what extent the forming and development of innovative infrastructures contributes for creation and spreading of knowledge and technologies.

The answers of those questions affect a number of trends including the innovative politics and the strategic frame of the enterprises that corresponds to the contemporary market conditions [2, 3]. Next is searching possibilities of Research and Development activity (R&D) and the close connection of business with such activities. A well as the search of weak spots of development of infrastructures for innovations and technologic transfer for their improvement, respectively the functions that they perform or are supposed to perform.

In their bigger part, the trends mentioned above, connected with the development of the innovative potential of many SMEs, are beyond their possibilities and they can hardly be achieved without external support. The above mentioned area of the enterprises determines the high risk exposure.

It is known that one innovative enterprise in Bulgaria is opposed to four or five innovative enterprises in the countries in EU. This shows very limited possibilities for competing with these enterprises.

Based on National statistical institute (NSI) data [8], the innovative enterprises including the technologically innovative enterprises, as well as the enterprises with

In the service sector, including sectors H, J and K, and sections 46, 71,72 and 73, the innovative enterprises are 22,1% and the enterprises with technological innovations are 14,1% [8].

These results show insignificant change in the results of the enterprises in the country from 2010 onwards, which is presented from the European comparative analysis of the innovations for 2017 of the European Commission (EC).

### 2.1. The technological transfer as an innovative engine for economic development and growth of the enterprises

The contemporary business environment, especially in the conditions of the ongoing Fourth Industrial Revolution

(Industry 4.0), creates many possibilities as well as many challenges for the enterprises and the way of performance of their production/operations capacity [10, 11, 12, 17, 19, 21]. It becomes more and more difficult to keep the dynamic balance between the way of functioning of the enterprises and the requirements and the characteristics of the business environment and achieving competitive privileges at the same time. The concomitant risks achieve such dimensions that is often difficult to be prognosticated and controlled.

Because all that the attention needs to be focused towards the demand of bigger complex of processes and activities so we can react to the dynamics of the business environment. This additionally impedes achieving the goals of the enterprises.

The realization of technological transfer creates possibility for the enterprises not only to take advantage of knowledge, experience and the technical novelties but they also expedite and increase the efficiency of their innovative activity [13]. This especially creates possibilities for improving their competitive power and their adaptation and positioning in the contemporary business environment.

The realization of technological transfers and innovations puts at first place identification to be done of the respective technological fields and next analysis to be done and overall assessment (qualitative and quantitative). On this basis the technological fields will be defined and respectively “applications” with potential for innovations in the enterprises.

In the last years in Bulgaria new guidelines were presented regarding the technological and innovative development of the enterprises including The National Program for Reforms 2014-2020, the National Program for Development: Bulgaria 2020, the National Transport Map for Scientific Infrastructure (2017-2023) was updated and so on. Of course this is not enough to create that environment where specific possibilities can be realized without the support and interference from the county side. In the last years underestimating the knowledge, science and innovations are one of the main and leading preconditions for not implementing innovative politics and realization of innovative potential that will bring stable economic growth. Platforms were created and they keep being created and it is not clear how they work and if they work at all. This way of action doesn't contribute for achieving better results and just the other way around. It is of great importance to create working technological platforms including national platform that do their role as a proper mediator between the main sides in the process of technological transfer – on one side the innovation – bearer and on the other side the innovation – user, securing the mechanisms of its realization.

It is difficult for big part of the enterprises in the country to take part in activities collaboratively, especially when it is about technological transfers, innovations and so on. They don't have the experience and traditions needed in this field and this additionally impedes their development and respectively the extent of their innovative potential. This is also one of the preconditions for achieving weak results.

Increasing the collaboration between the enterprises on one side is an important condition, and that way they can help each one whenever possible. On the other side, even this is a strong connection, it will be difficult to implement any innovative activity without the help of those which create this innovation – universities, scientific units, research teams and so on. The connection between a university and a

business is not at the level needed even it is said that it exists. That's why it is necessary the collaboration between universities and business to be increased, as well as different alternatives and contemporary approaches, methods and solutions (including digital ones that are components of Industry 4.0) to be implemented – Internet-of-Things (IoT), Big Data, Digital Factories, Blockchain, Education 4.0 etc. [7, 9, 20].

## ***2.2. Innovative capacity of the enterprises.***

An important element of the whole concept is the innovative capacity of the enterprises. Each enterprise has different needs and readiness for realization of these needs especially when we are talking about technological transfer and innovations.

The category “capacity” of the enterprises for adopting new technologies characterizes their ability to recognize, adopt and use the novelties in time [1].

In spite of the fact the part of the innovative activity of the enterprises in Bulgaria in the years after the country became part of the EU has been increased, it keeps being at low level. In 2017 the expenses for research and developmental activity are 760,2 million leva which is with 3,5% more than the previous year. The intensity of R&D (measured as a percentage of the expenses for R&D activity from Gross domestic product (GDP) decreases from 0,78% in 2016 to 0,75% in 2017 [8]. For EU, the data for 2016 is 2,04% [15], which is 2,7 times more.

On a global scale Bulgaria is at 68th position for innovations with value 3,3 out of 137 countries [16].

The EU results in the field of innovations based on the database of European Comparative Analysis of innovations shows that it has been increased with average 5,8 percentage points from 2010 onwards [5].

The capacity of the enterprises is connected to and depends on the company strategies for development and respectively their realization. Precisely it will predetermine their innovative potential in the future. It depends on the enterprises themselves if they will take advantage of these conditions and if they will focus their efforts in this direction. Moreover, it will be of great importance if they are searching possibilities for development of the innovative capacity.

The realization of technological transfer is connected to the proper assessment of capacitive possibilities of the enterprises and their absorption capacity. Each enterprise needs to make correct evaluation of its possibilities and after that to proceed to realization. This is one of the serious problems that needs to be resolved. According to Velev and Atanasova [1], the results from the increase of the absorption capacity has three stages: increase of company knowledge, results of the different innovations, increased competitiveness of the enterprise. Undoubtedly this is true and the evaluation that needs to be done will contribute to determine the future possibilities regarding realization and technological transfers. They are being implemented on the basis of absorption capacity, for example enrichment and extension of the knowledge, how far and in which way the implemented innovations contribute for the company activities, development and so on.

Another important aspect with great significance is the development of the national innovative system in the country. At that moment it still shows weakness and non-balance. This affects the enterprises regarding the



innovations and their competitiveness. Our country keeps being associated with the so called “modest innovators”, which means that a lot of work needs to be done in this sphere.

### 3. Conclusion

The realization of technological transfer and increase of the innovative activity in the enterprises in the contemporary business environment are in the base of their development and competitive power. This creates many possibilities and much better conditions for their proper functioning and positioning in the contemporary business environment.

The few trends that are mentioned are related to building and development of the innovative potential of the enterprises in Bulgaria. Our attention need to be focused towards some main weaknesses that were mentioned. Their solution will contribute for the improvement of the current condition and will help refining of the infrastructures for innovations and technological transfer in Bulgaria.

### 4. References

1. Велев М, Атанасова С., Технологичен трансфер в индустриалното предприятие, първо издание, София, 2013, ISBN 978-954-334-146-7
2. Дамянов Д., Демирова С. Иновации и иновационна политика във високоавтоматизираните производства, 2019, ISBN 978-954-760-476-6 ,КОЛОР ПРИНТ – Варна .
3. Дамянов Д., Малък и среден бизнес – организация и управление..Издателство ТЕМПОРА, 2010, ISBN 978-954-91851-7-1
4. Даскалов, Х. и Колева, Н., Управление на проекти за отворено сътрудничество в рамките на “триъгълника на знанието” на локално и регионално ниво участие в 16-та международна научна конференция „Мениджмънт и инженеринг‘18“, 24-27 юни, Созопол, 2018, ISSN 1310-3946.
5. Европейски сравнителен анализ на иновациите за 2018 година, [https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards\\_bg](https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_bg)
6. Карев, Н., Влияние на инвестициите в технологичен трансфер върху конкурентоспособността на предприятията за производство на облекло. Юбилейна научно-приложна конференция – Предизвикателства пред индустриалния растеж в България. 12-14 Октомври, 2018, ISBN 978-619-7009-12-5.
7. Колева, Н., Методика за изследване степента на развитие на дигитализацията на производството в българските индустриални предприятия, участие в 16-та международна научна конференция „Мениджмънт и инженеринг‘18“, 24-27 юни, Созопол, 2018, ISSN 1310-3946.
8. Национален статистически институт, <http://www.nsi.bg/>
9. Andreev, O. and Daskalov, H., A Framework for Managing Student Data through Blockchain, 10th Anniversary International Scientific Conference “E-Governance and E-Communications” – Conference

- Proceedings, Sozopol, 2018, ISSN 2534-8523, pp. 59 – 66.
10. Andreev, O. and Peneva, G. , A Methodological Approach to Survey the Opportunities for Implementing Industry 4.0 in Bulgarian Industrial Enterprises, 16th International Scientific Conference „Management and Engineering‘18“, 24-27 June, Sozopol, 2018 ISSN 1310-3946, pp. 739 – 745.
11. Andreev, O. and Peneva, G., Problems Concerning Operations System of the Enterprise in the Context of Industry 4.0, 10th Anniversary International Scientific Conference “E-Governance and E-Communications” – Conference Proceedings, Sozopol, 2018, ISSN 2534-8523, pp. 165 – 170.
12. Andreev, O., Dakov, I. and Nedjalkov, L., Introducing Total Productive Maintenance System in a Bulgarian Industrial Enterprise, 16th International Scientific Conference „Management and Engineering‘18“, 24-27 June, Sozopol, 2018, ISSN 1310-3946, pp. 697 – 706.
13. Atanasova S , Kostova D., PRE-ASSESSMENT OF TECHNOLOGY TRANSFER OPTIONS IN THE INDUSTRIAL ENTERPRISE, [https://e-university.tu-sofia.bg/e-publ/files/1023\\_Doklad\\_S.Atanasova\\_D.%20Kostova.pdf](https://e-university.tu-sofia.bg/e-publ/files/1023_Doklad_S.Atanasova_D.%20Kostova.pdf)
14. Damyanov D., Innovations - technology, organization, management, financing, politics, 2013, Ed. Primax, Rousse.
15. Eurostat Statistics Explained, [https://ec.europa.eu/eurostat/statistics-explained/index.php/R\\_%26\\_D\\_expenditure](https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure)
16. Global Competitiveness Index 2017-2018, <http://reports.weforum.org/global-competitiveness-index-2017-2018/competitiveness-rankings/#series=GCI.C.12>
17. Karev, N., A. Terzieva, Clarification of the correlation between the technological transfer and the enterprise competitiveness, Science, Engineering, Education, Volume 1, Issue 1, S, UCTM-Sofia, 2016, ISSN 2534-8507 /print/, ISSN 2534-8515 /on line/ Karev, N., A.
18. Karev, N., A. Terzieva, Analysis and assessment of technology transfer opportunities in the apparel manufacturing sector, Science, Engineering & Education, Volume 2, Issue 1, S, , UCTM-Sofia, 2017, ISSN 2534-8507 /print/, ISSN 2534-8515 /on line/
19. Koleva, N. & Andreev, O., Influence of Degree of Customer's Co-Participation on Their Assessment of Products Design and Functionality, Economic Alternatives Journal, Issue 1, 2015, ISSN 1312-7462, pp. 91-99.
20. Koleva, N. & Andreev, O., Aspects of Training in the Field of Operations Management with Respect to Industry 4.0, International conference on High Technology for Sustainable Development, 11-14 June, 2018.
21. Koleva, N., Industry 4.0's Opportunities and Challenges for Production Engineering and Management, International Scientific Journal Innovations, issue 1, pp. 17-18, 2018, ISSN 1314-8907.

# EFFECTS OF THE INNOVATIONAL DEVELOPMENT OF ENERGY SOURCES BASED ON THE USAGE OF DOMESTIC WASTE

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**Annotation:** Given that the topic of the invention of new technologies for the usage of alternative energy sources is following an ascending rate of constant innovative solutions, the problem with the detection of all iconomical and ecological side effects also needs to be brought to attention. Similar is the problem with the usage of renewable energy sources based on domestic waste which is also developing in that direction. This is why the intensive factors for the progress of this process are changing their dimensions and are going to be closely related with both the effective usage and improvement of the technologies, and the raising of the overall efficiency, taking into account the benefits of solving social, ecological, household and other problems. Also similar is the problem with the domestic waste used as raw material for renewable energy sources. The subject of observation of this present article is the development of this process based on innovation and the raising of its efficiency, also taking into account the side effects related to the ecology, solid and domestic waste. Measurement indicators for these effects with unified dimensional unit (leva) are suggested and an approach for measurement of their manifestation is formulated.

**Key words:** RENEWABLE ENERGY SOURCES, DOMESTIC WASTE, NEW TECHNOLOGIES FOR WASTE TREATMENT ETC.

## 1. Introduction

Solving the problems of the development of alternative energy sources through usage of domestic sources imposes a re-view of the traditional or conventional approaches to forming the requirements for the reporting of effects of their application. The development of this process has to be combined with both the usage of modern technologies and technics and the search for more flexible forms of organization for application with all economical side effects. With that, the consumption of electricity is one of the main social bases for the survival of population, and the usage of energy resources, on the other hand, is one of the main sources of greenhouse gas emissions. The world is facing the challenges of the climate changes caused by the increase of the amount of greenhouse emissions. Because of this stable energy development the reduction of greenhouse emissions is outlined as the main goal of the world energy policy.

The usage of renewable energy sources is looked at as one of the main impactful factors for transitioning to low-carbon economy, for the development of new high tech production and the provision of the so called "green" growth and "green" workplaces. The effectiveness of production of renewable energy sources is defined by the demand of the offered services / production. The appeal of the end product depends on the amount of the waste generated in the process, which is predetermined by the amount of the population served [3,10]. Therefore, the influence factors on the effectiveness of renewable energy sources can be said to be the factors that define the amount of demand or the amount of the waste generated.

They are Internal factors consisting of: amount of population that is going to be served by the depot and the tendencies in the demographic development of the region [5], which includes:

- The economical state of the population – in particular increased or decreased consumption

- The growth of the business environment in the region. For electricity to be generated from RES (biomass), good conditions for the collection, disposal, temporary storage, separation, landfilling and burning, composting, pre-treatment and production of electricity from the generated waste need to be assured.

**External factors:** Main external factor that affects it is the Bulgarian EU membership. The special regulations concerning the renewable sources of energy have a great impact. The usage of RES is looked at as one of the main impactful factors for transitioning to low-carbon economy [7].

**1. Forming an approach to determine the economical side effects of constructing a RES using domestic waste.**

## Financially-economical structure of the expenses and incomes of the electric energy generated by the RES using domestic waste.

In the process of formulating the current approach the concept of the financial analysis is being used and the only thing being looked at are the cash flows as the non-monetary, including accounting entries, depreciations charges and reserves for unforeseen expenses are not included. Also not included are cash flows for VAT. Cash flows are considered in the year in which they arose and for the defined above reference period. The European and national standards for acceptable and unacceptable expenses.

## Structure of the expenses for production and distribution of the electricity based on domestic waste.

The technology (production) of electricity is being served and accompanied by many cost activities (economical, financial, exploitational, social, maintenance, repairs etc.). This environment is special in its structure and components and is established as unified. One of the components of this structure is the cost analysis for the technological cost of a unit of produced electricity.

It is known that the expenses for the production can be classified into: variables (a) and conditionally-constants (b). The general expenses are determined by the relation [1, 2]

$$C_Q = aQ + b$$

where:

$a$  – variable expenses;

$b$  – conditionally-constant;

$Q$  – amount of produced electrical energy

For the purposes of the regulatory mechanism when determining the needed income and its components the following types of expenses, prices and price-formatting factors of electricity are being applied. The conditionally-constant expenses are determined by the electricity distribution companies based on a projection for the regulational period and presented jointly and separately for the following activities:

1. Maintenance of the distribution networks;
2. Development of the distribution networks, related to connecting consumers;
3. Supplying the end users.

Except in that way, expenses are also classified as follows:

**Technological expenses.** They include the acceptable technological cost amounts for the production, transfer and distribution of electricity. These are expenditures of electrical energy that are inherent to the technological processes of transferring and distributing electrical energy (networks, transformers, means of measurement, load schedules, distributed energy, etc.). The energy companies have the right to compensate for these expenditures

through the price of transfer/distribution of the electrical energy. They are defined as a percent of the purchased electricity. In that case, they belong to the variable expenses.

**Unrecoverable expenses.** These are expenses including already made investment and/or done deals that cannot be undone as they are connected to the transitioning to a competitive electricity market as well as expenses resulting from the completion of obligations to the society, including ones related to the security of the supply, protection of the environment and energy efficiency.

Another way of sorting and classifying is by phases of the process, or in other words – investment and operational phases.

**Investment phase.** The investment phase includes “Construction of an integrated system of installations for domestic waste treatment”.

**Operational phase.** The expenses in the operational phase arise after the realization of the construction phase and extend for 30 years from the projection period when the reference period of the projects expires. For a more detailed representation, the expenses in this phase are separated into two groups, maintenance expenses and operational expenses respectively.

**Consistency and evaluation of the incomes forming the financial result**

For an evaluation of the relevance of the strategy for renewable energy source electricity production development, cash flows need to be worked out in the within the reference period. The reference period is a period in years to which the projections, included in the analysis of the expenses and incomes, refers to. The projections of the project cover a period corresponding to the economical profitable life span of the installations and the depot, and long enough to cover its probable long term impacts. The reference period horizon by sectors (based on the international practice and recommended by the European Commission) fixes a period of 30 years for the sector of the environment [7].

Incomes are expressed in the price of landfilling that the private and the public consumers pay. The receipts are estimated and corresponds to the “analysis of demand” in which the amounts of deposited by the interested parties waste are settled. The estimated fee is calculated based on a ton of landfilled waste as the projection is based on the average prices for depositing a ton of waste in an already existing depots for non-hazardous waste [3,11].

**Determining the cash flows**

In summing the cash flows actualized throughout the years, the time value of the money is determined. From this follows that the future cash flows get discounted to the present moment using a decreasing with the time discount factor whose value is determined according to the discount rate. The used for the purpose of the financial analysis discount rate reflects the alternative price of the capital for the investor. It is determined as a missed return from the best alternative project. The Commission recommends 5% financial discount rate to be applied in real terms as an indicative purpose for public investment projects, co-financed by the Funds. The present analysis takes for the value of the real financial discount percent to be 5, 0%. The cash flows can be positive or negative.

**Positive cash flows**

The financial incomes are expressed in the price of the landfilling that the private and public consumers pay. The receipts are estimated and corresponds to the “analysis of demand” in which the amounts of deposited by the interested parties waste are settled. The estimated fee is calculated based on a ton of landfilled waste as the projection is based on the average prices for depositing a ton of waste in an already existing depots for non-hazardous waste in Bulgaria. The cost of disposing of a ton of waste to the public is determined on a real cost basis and is within the competence of the City Council. Given the nature of the landfill - whether regional or not, and the presence of municipalities, we have set the cost of landfill waste based on the maintenance cost and the average cost in

the present moment, assuming that the landfill is managed as an independent economic unit.

**Negative cash flows.**

The negative cash flows are:

- Investment costs
- Operational costs
- Maintenance and repair costs

**2.Consistency of execution of the approach to determine the side effects of the construction of RES using domestic waste.**

**Discounted – positive and negative cash flows.**

The discount rate reflects the public norm of time preferences[1,3]. The norm of time preferences expresses the ratio between future and current consumption. In the long run, it should be aligned with the market interest rate. Thus it expresses the norm of time preferences of the whole society. It is this norm that is adequate for the purposes of analyzing and evaluating public projects in modern economy.

The public discount rate is the minimum required rate of return from the public investment project. If the expected return is below this rate, the project should not be funded if only the financial effect is important.

The discount rate used for the purpose of the financial analysis reflects the alternative cost of capital for the investor. It can be defined as a missed return from the best alternative project. It is recommended as an indicative target for public investment projects co-financed by the Funds to apply a 5% financial discount rate in real terms.[7] In order to create the conditions for comparability of financial projections over the projection period and eliminate the "time" factor, which is fundamental to the importance of the value of money during the period, it is necessary to perform a so-called discounting of the flows. In this case, all streams will be brought to a time point by discounting. The use of this method ignores the inflationary processes that would develop in the country and, at the same time, the interest rates. Although our currency unit is directly related to the EURO as a means of payment, deviations from inflation and interest rates in some EU countries have been noticed. In practice, the only thing taken into account is the risk in the project. When the projection is developed, the practice of so-called "stop prices" is used, ie it is operated at the same price level for all services offered throughout the projection period. The same applies to the prices of materials and energy [7,8]

**Determining the actual performance indicators**

**Net present value (NPV)**

The purpose of this approach is to determine the net financial effect of the project realization, evaluated at the starting point of the reference period.

The methodological approach is to apply the following procedure:

- The investment costs projected are divided by the years of their implementation;
- The current investment costs are calculated and summed up;
- The net cash flows generated in the implementation of the project on an annual basis are determined. We have to say that this is an "internal" project year, which does not always coincide with the calendar, resp. with the accounting year. For this purpose, a fiscal accounting approach is chosen - eg. by normalizing the first reporting period to a duration of less than a year.
- the current net cash flows are computed and summed up.

The cash flows in the financial analysis of the investment during the first years of the projection period are negative, while in the following years they are positive. Given the theory of money movements over time, negative values in the first years have a greater weight than positive values in recent years. This means that the choice of the time horizon is of utmost importance for the definition of NPV. **There are two types of Financial NPV - investment and capital.**

The Financial Net Present Value of the Investment (FNPV / C) is the sum of the discounted cash flows of the investment for the entire planning period, and for this project (household waste) it is negative. This means that the cumulative effect of the investment that will be made is also negative as a whole, or in other words, the discounted revenue for the entire projected period will not exceed the total costs. With such indicators, projects are usually inefficient and unattractive to investors. On the other hand, however, FNPV / C indicator like this is common for public projects dominated by the social factor. In this case, the negative value of FNPV / C is mainly indicative of the impossibility of the project implementation in the absence of an EU grant scheme [4,7,8].

There are, therefore, several groups of problems –

**The first group** of problems is related to the correct determination of the distribution of investment costs as well as to the estimated cash flow projections during the project period. A long-term projection is set within the reference period. Moreover, the volatility of the forecast is further increased by the fact that we discount the cash flows and investment costs, i.e. this determines the flow pattern over time and makes the risk distribution in otherwise symmetric investment decisions marked asymmetrically.

**The second group** of problems are domestic, social and environmental.

#### **Internal rate of return (IRR)**

The internal rate of return is the ratio of the profits made to the investments made. The simplest way to estimate profitability is to measure the internal rate of return on investment, i.e. the discount rate, where the sum of the discounted cash flow of costs and project revenue gives zero [1,7].

The expected IRR may be strictly dependent on the risks inherent in the project. In turn, the risks depend on a number of factors, including: the socio-economic conditions in the municipality where the project is being implemented, the difficulties with the project implementation, its economic life, the exchange rate risk and, above all, the risk related to the planned revenue. These elements should be properly addressed in the sensitivity and risk analysis.

In the present case, similar to the financial net present value of investment and capital, and the financial internal rate of return on investment (FNPV / C) is negative. The financial internal rate of return on capital (FNPV / K) is also negative, but at the same time higher than the financial performance. The financial model of the investment does not show a return on the project. This means that the project can not be implemented in the order of usual project financing [3]

#### **Profitability Index**

In this approach, we calculate the effect of a unit of invested capital that is relevant to the most commonly used rationality criterion. The application of this approach is characterized by the fact that benefits (income and positive influence) are compared to costs (including negative influence). The range of the coefficient boundary is +/- 1. [1,4,8,9] and includes the influence of: Introduction of new economic indicators;

Price distortion of incoming and outgoing resources.

Current input and output resource prices can not reflect their social value due to market distortions, e.g. monopoly regimes, barriers to trade, etc. Current prices resulting from market imperfections and pricing policy in the public sector may not reflect the alternative cost of inputs. In some cases, this may be relevant for project appraisal, and financial data may be misleading as indicators of well-being [5,7].

In some cases, prices are regulated by the state to compensate for the perceived market failure in a way that is in line with its policy objectives, indirect taxation is used to correct external factors. In other cases, however, real prices are distorted due to legal constraints, historical reasons, incomplete information or other market imperfections (eg feed-in tariffs such as energy, fuel). An example of price distortion is a project requiring

significant terrain, e.g. a production site (as in the present project) whereby a public authority provides the land free of charge, where otherwise it could collect rent; These distortions are directly related to social problems.

#### **Distortions in the labor market**

Labor distortions (minimum wages, unemployment benefits, etc.) generally lead to a situation where the wage is higher than the alternative labor cost.

Adjustments from market to book prices can be made in addition to fiscal and external factors when:

- Actual input and output resource prices are distorted due to market imperfections;
- Wages are not related to labor productivity.

When it comes to the labor market, a lack of distortion was accepted, so no shadow wage was calculated. But essentially, here we have an influence on the social factor as well [3,6].

#### **Adjustment of market prices:**

The economic analysis of the project requires adjustments to the market prices used in the financial analysis. Market prices are considered to be remote from their long-term equilibrium due to numerous distortions due to taxes, subsidies, import duties and other financial transfers. To reflect the alternative costs, economic data should account for external impacts and eliminate all types of financial transfers [4,6].

Commodity in free circulation in international trade shall be subject to a standard conversion rate to adjust the market price and to calculate the accounting prices that reflect the alternative costs. World market prices represent the real trade opportunities of the country and are thus an appropriate measure for alternative costs. In this case, we must take into account the impact of all three factors, domestic, social and environmental.

#### **Method of calculating present economic net value and economic rate of return**

A model conforming to the concept of the financial analysis model has been prepared for the calculation of the PENV and the ERR. Flows that are discounted reflect economic benefits and costs, rather than purely financial flows.

Costs and benefits that occur at different times should be discounted. The discounting process takes place, just as in the financial analysis, after the economic analysis table has been determined. The discount rate for the socio-economic analysis of investment projects - the so-called social discount rate - is an attempt to reflect the social point of view on how the future benefits and costs should be measured against the current ones.

After determining the amount of economic costs and benefits, the standardized discounted cash flow methodology is applied, using a social discount rate. Based on the long-term level of economic growth and the theoretical preference levels,

#### **How to calculate economic indicators and determine the effectiveness of the approach.**

After adjusting the price distortion, it is possible to calculate the economic rate of return (ERR). After selecting an appropriate social discount rate, it is possible to calculate the economic net present value (ENPV) and the benefit / cost ratio.

The difference between ERR and FRR is that the former uses accounting or alternative prices for goods and services instead of imperfect markets and, as far as possible, includes social and environmental externalities. Since in this case external factors and shadow prices are taken into account, most projects with low or negative FRR will prove to have positive ERR.

#### **Conclusion.**

In conclusion, it can be assumed that an approach is proposed for calculating the economic indicators at the stage of designing, applying and using RES from domestic waste. In addition, economic performance indicators can be defined in the first phase - design phase.

After adjusting the price distortion, it is possible to calculate the economic rate of return (ROI). After selecting an appropriate social discount rate, it is possible to calculate the economic net present value (INIC) and the benefit / cost ratio. The Economic Net Present Value (NNS) must be greater than zero in order for the project to be economically feasible. Economic rate of return (ROI) must be greater than the social discount rate;**Literature:**

1. Angelova, Y., Issues of the liberalization of the electricity market in Bulgaria. Sofia., 2008
2. Angelova, Y., Determining the price of the electric energy. S. 2008
3. Ivanov, Alexander Dimitrov., Waste: Socio - environmental problem of the global society: Model for solving / Alexander Ivanov. - [Sofia] : RA Euromedia, 2015.
4. Donchev, Dimitar., Financial analysis; Sofia 2009
5. NSI (2015) Energy balances 2013, Sofia
6. Costs and benefits of renewable energy sources in Europe up to 2030, DIA-CORE Policy Brief, June 2014.
7. CEER (Council of European Energy Regulators) (2017), *Status Review of Renewable Support Schemes in Europe*, CEER, Brussels.
8. CEER (Council of European Energy Regulators) (2017), *Status Review of Renewable Support Schemes in Europe*, CEER, Brussels.
9. Koleva, N. & Andreev, O. (2015). Influence of Degree of Customer's Co-Participation on Their Assessment of Products Design and Functionality, *Economic Alternatives Journal*, Issue 1, ISSN 1312-7462, pp. 91-99.
10. Koleva, N. (2018), Industry 4.0's Opportunities and Challenges for Production Engineering and Management, *International Scientific Journal Innovations*, issue 1, pp. 17-18, ISSN 1314-8907;
11. В. Спасова „Създаване на базирани на знания визуални съветващи системи с Astor Prolog”, Втора национална научна конференция „Информатиката в научното познание”, ВСУ „Ч. Храбър”, юни 2004 г.

# INNOVATION TODAY - A COMPLEX INNOVATION APPROACH TO SOCIAL AND TECHNICAL INNOVATIONS

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**Abstract:** *Innovation is a key component of the development of the economy, the competitiveness of national economies and the high quality of long-term performance. To acquire and maintain competitiveness is strongly dependent today on innovation. For many years innovation related studies concentrated on technological innovation. Although Schumpeter has defined innovation in a broader sense, including market and organizational innovations as well, studies mainly have left out of consideration the economic, managerial and social elements of innovation. During the last 15 to 20 years social innovation has emerged as a major area of studies in innovation. How do all the actors of the economy see it? How does one help each other? We seek answers to these questions in a research on innovation and social innovation in a wider area, from which the present study focuses on social attitudes in technical and social innovation.*

**Keywords:** TECHNICAL INNOVATION, SOCIAL INNOVATION, COMPETITIVENESS, SOCIAL ATTITUDES

## 1. Introduction

Innovation, as a key element of economic development, is an essential factor in social processes. Theoretical antecedents of the concept of innovation appeared in Schumpeter's Theory of Economic Development (1912). Schumpeter clearly considers innovation as the driver of the boom, and has attributed a crucial role to the creative entrepreneur. He identifies the concept of development with creating something new, and limiting it to innovation, which is the way as the entrepreneur exists. He distinguishes five types of innovation: the creation of a new product, the introduction of a new production process, the penetration to a new procurement market, the penetration to a new sales market, the development of a new organizational form (Schumpeter, 1912).

Gloria-Palermo (2005) emphasizes the dynamic concept of the entrepreneur's role. In this manner, the creative entrepreneur must have additional purchasing power to obtain the production assets, which is provided by credits from banks. Innovations result in temporary profits until they are massively adapted. Interesting to mention that Schumpeter's teacher, Friedrich von Wieser, identifies the entrepreneur as „a brave technical innovator, an organizer who knows human nature deeply, a visionary banker, a daring speculator, and a world leader of trusts” (Madarász, 2014, p.17).

## 2. Technical and social innovations

Schumpeter identified innovation as the reason for economic growth. In his interpretation, innovations lead to economic and technological development. From the second half of the 1900s, the notion that technological development and progress means not merely technical innovation, but also social innovations that bring about the renewal of society, becomes accentual. In 1970, Dénes Gábor examined several types of innovations, and attributed the lag of efforts to increase social welfare to the predominance of technical innovations. According to him, social initiatives can be identified as reforms controlling innovation (Gábor, 1970). According to Drucker, innovation is needed in all fields of life, and it must not be limited to technical or economic fields, but it is also a social category, and with this theory he deepened the concept of social innovation (Drucker, 1985). Smeds (1994) identifies technological innovations as prerequisites and causes of social change. According to Introna et al. (1999), technological innovation cannot be created without the renewal of society. According to the „expanded” interpretation, innovation is a new or significantly improved product, process, marketing method, or organizational method in business practice, organizations, or collaborative relationships (EC, 2006). The definition is a guideline related to primarily technical and economic innovation, but the European Union's programme for research and development and innovation

policy (Horizon 2020), however, already pays particular attention to defining social innovations. Murray et al. (2010) investigated novel social cooperation and, in their opinion, new structures are developing new social solutions to address social problems through technological development. Franz et al. (2012) examine technical and social innovations and emphasize the importance of the issue, whether innovations that bring new technological achievements are useful to society in all cases. In their view, 'new' is not necessarily a good and desired category, social innovation endeavours are widespread and accepted in a wide range of societies.

Technological and economic innovations cannot be an answer to all social challenges. Natural and material resources are becoming more and more scarce, so it is necessary to use investment assets as rationally as possible, maximizing social and economic efficiency. Social challenges requiring long-term solutions (eg. unemployment, migration, economically disadvantaged areas) demand new social cooperation. Social innovation is a necessary step towards improving development and competitiveness, where the role of innovators is crucial. Innovators are members of the local community or, in a broader sense, of society, who, in the light of their needs, find new or novel solutions to meet their needs determined by social challenges. Social innovation „provides new or novel responses to the problems of the community with the aim of increasing the well-being of the community” (Kocziszky et al., 2017, p. 16). In addition to raising the standard of living, the emergence of novel structures and the promotion of society's ability to act can be emphasized, where social innovation can be identified as a process of increasing willingness to act (Balaton-Varga, 2017).

It can be stated that social innovations are inseparable 'companions' of technical innovations, innovations can be interpreted as complementary processes. New innovative bases - like the field of social innovations - help to implement technical innovations and their efficiency, while being able to respond to the current challenges of society by increasing each other's strength (Varga, 2017). The different types of innovation interact and lead to the transformation of economic and social relations.

## 3. Factors influencing innovation at individual and organizational level

Several authors have attempted to enumerate the elements that stimulate and help innovation. When examining management, we need to take into account important features of innovation, such as the supportive environment, the ability of the organization to recognize market opportunities and threats, or the commitment to technological development, the willingness to innovate, and the availability of expertise and capabilities (Piskóti et al., 2012). According to Derecsky (2012), the personality of the innovator is

decisive when judging an innovation idea. According to Niclas Trouvé, Hungarian ambassador of Sweden, the characteristics of the innovator determine the innovator ideas of the organization. Representatives of empirical research based on the personality-based approach of innovation (Rogers 1983, Becker 1970, Boone, 1970) have introduced personality traits as an explanatory variable in their research when examining innovation.

To summarize what is needed for innovation: a good idea and an innovative person, as Schumpeter (1980) described. The characteristics of the creative innovators described by Schumpeter have been empirically tested by Judit Rimler (1998, 1999). Based on in-depth interviews with successful entrepreneurs, she summarizes the personality traits that characterize them, the „real creative entrepreneurs are those who invent something for which have not had any demand before.” (Rimler, 1999, p. 54)

Based on the synthesis of the above statements, we can conclude that the conditions may appear at the individual level, at the organizational level, or there may be external incentives as well. This is in line with the recommendation for innovation management developed by the European Technical Committee. In our previous research (Deák-Kiss, 2017, Tóth-Kiss, 2017) we examined the factors related to different external conditions, but we would only address the individual and organizational level in relation to the topic of this study. On the basis of the reviewed literature we developed our own influencing factors of innovation, which were also used during the questionnaire.

**4. Research**

In recent years, we have carried out much empirical research to examine business and social innovation, in which we tried to utilize the experience gained so far. The results presented in this paper are based on the results of a broader research on business and social innovation attitudes, aimed at exploring innovation endeavours (both business and social innovations) from the perspective of all concerned.

The aim of the research is to explore stakeholders’ attitudes towards business and social innovation.

Our research questions are the following:

- how the members of society perceive innovation activities around them,
- what can be the purpose of the activities,
- what are the conditions that help or inhibit innovation,
- what kind of personality should the innovators have?

In the examined group, 256 people made up the complete population that met our criteria. Agreeing with the literature (Bulut et al., 2013, Krlev et al., 2014, Balaton-Varga, 2017, Tóthné Kiss – Varga, 2017) we accept that pioneers of innovative thinking and potential innovators are former and current university students with diverse socio-demographic, geographical and cultural background. Where there is no opportunity for the implementation of business innovation, social innovation can be a new tool or model for successful innovation. Reducing regional differences and increasing regional competitiveness are decisive factors in the innovation processes of certain disadvantaged areas, which are indisputably essential. This innovation process is particularly important in disadvantaged areas (eg. Northern Hungary). Accordingly, the questionnaire was sent to the former and current students (examining student status for the past 10 years) of the University of Miskolc (as the leading institution of higher education in the region). Respondents are from various university faculties (mechanical, economics, law, healthcare, arts, music institute). The online survey took place in December 2018 and January 2019. The questionnaire consisted of two main parts: on the one hand, we collected demographic data and, on the other hand, information about business and social innovation. In the second part, we tried to identify the concept, successes and examples of business and social innovation, as well as the stimulating factors and barriers. In addition, we asked the respondents to prioritize 12 characteristics to

identify the personality traits that generate business and social innovation.

**5. Results and discussion**

We tried to meet the strict sample selection and methodological requirements of the innovation surveys in our research. 54.8% of the non-representative sample population are female and 45.2% are male. In terms of age distribution:

- 18-28 years: 20.4%
- 29-38 years: 45.5%
- 39-48 years: 19.6%
- 49-58 years: 12.2%
- 59-68 years: 2.3%

The ratio of respondents who live:

- in a city (over 100,000 people): 45.3%
- in a town (between 20,000 and 100,000 people): 10.5%
- in a small town (up to 20,000 people): 22.3%
- in a municipality: 2.2%.

The base population, taking into account the innovative motivations of the above-mentioned university students, can be described by the highest level of education and occupational distribution as follows:

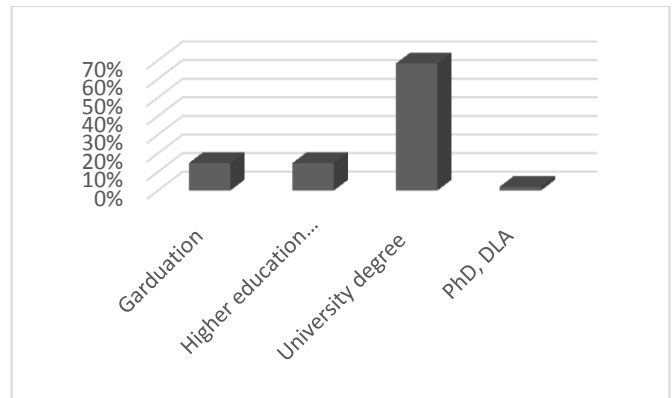


Figure 1: Highest level of education of respondents, (%), n=256, Source: own construction based on the survey

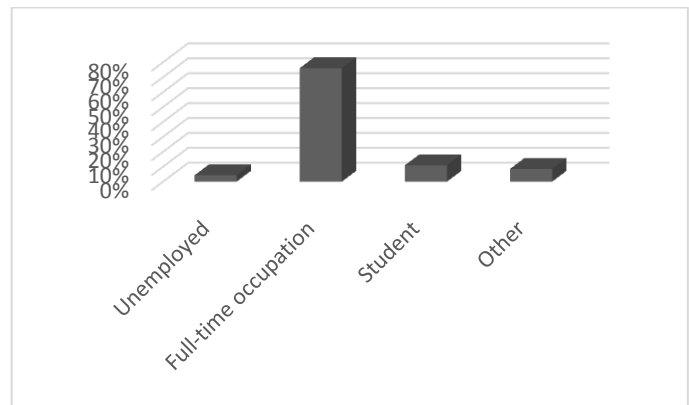
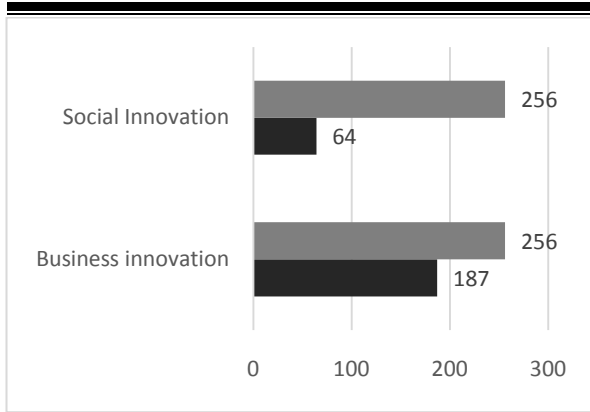


Figure 2: Occupational distribution of respondents, (%), n=256, Source: own construction based on the survey

In accordance with the research questions, the following statements can be made for the sample as the results of the survey:



**Figure 3:** Assessment of respondents regarding social and business innovations, (pcs answer), n=256, Source: own construction based on the survey

About two-thirds of the 256 respondents has already met with business innovation at their place of residence, which they successfully identified. It can be seen that barely one-third of the sample recognized social innovation activity around them, which on the one hand may refer to the less well-known concept of social innovation, and on the other hand assumes that the region’s social innovation activity is not typical. This picture is underlined by the fact that 53 of the 64 respondents with positive answer mention a concrete example of their residence, as well as having information of other (even international) practices. In our opinion, this rather suggests that knowledge about the process of social innovation is less common in the analyzed sample.

In line with our research question, we wanted to find out whether respondents thought that there was a difference between the aims of business and social innovation.

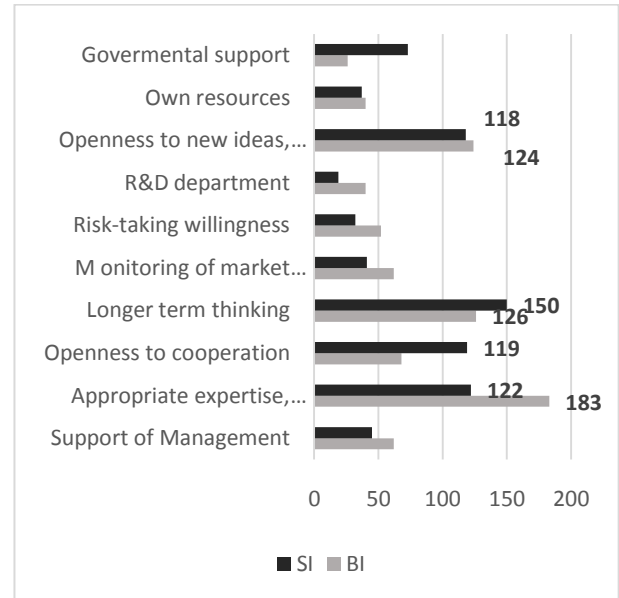
**Table 1:** Aim and motivation of business and social innovation activity (pcs answer), n=256, Source: own construction based on the survey

	Business innovation	Social innovation
Realization of financial results, profit	139	48
Social welfare	38	175
Quality improvement	107	67
Cost reduction	91	48
Process development	70	41
Increasing competitiveness	129	52
Reducing environmental pollution	43	82
Exploring new markets	52	29
Create a new product / service or procedure	66	29
Reduce energy consumption	32	53

Our assumption has been confirmed as respondents associate social innovation with a goal concerned to social welfare based on a prominent mark (175 pcs.), while for business innovations it is divided, but three motivational reasons can be identified here: realizing financial profit (139 pcs.) , improving competitiveness (129 pcs.) and improving quality (107 pcs.). It can be stated that - in agreement with the literature (Hazel, C. - Onaga, E., 2003, Mulgan, G. et al., 2007, Pol, E. - Ville, S., 2009, Cajaiba-Santana, G., 2013) - for social innovations, respondents are clearly associate some kind of aim for improving social welfare, while in the case of business

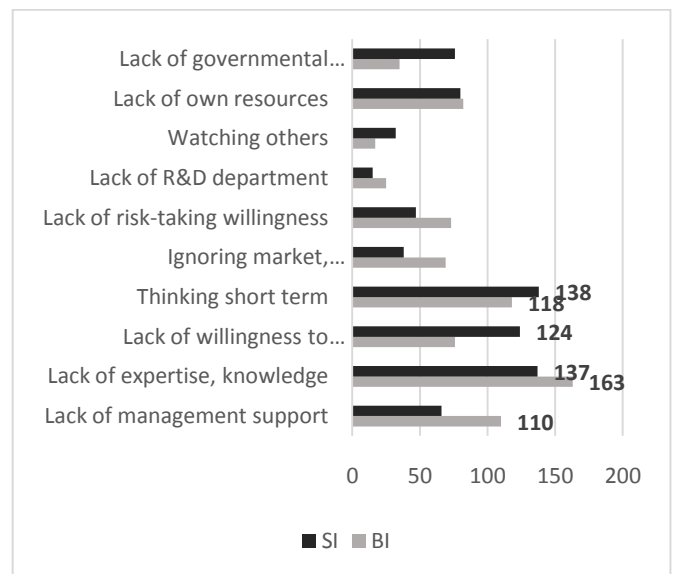
innovations some market, operational efficiency improvement. In both cases, the least mark of the answer options was the increase of the organization value, the expansion of the product range, the reduction of the material demand and the adaptation to the regulators.

In the survey, we asked the respondents to mark the three most important factors from the possible answers that they consider the most helpful for business and social innovation, and in another question by listing the same factors, the three most important factors that hinder business and social innovations the most.



**Figure 4:** Factors stimulating business and social innovation, (pcs answer), n=256, Source: own construction based on the survey

In the case of business innovation, the three most important stimulating factors are the appropriate expertise (183 pcs.), longer-term thinking (126 pcs.), and openness to new ideas, learning from others (124 pcs.). The same responses were marked in the case of social innovation as well, with the addition of the same number of marks (119 pcs.) with openness to cooperation at the third place. Openness to cooperation in business innovations has only been chosen by 68 respondents, which means that the respondents - in line with the literature review (Mumford, DM et al., 2002) , F. - Manzini, E., 2008, Moulart, F. et al., 2013), identify it with social innovation.

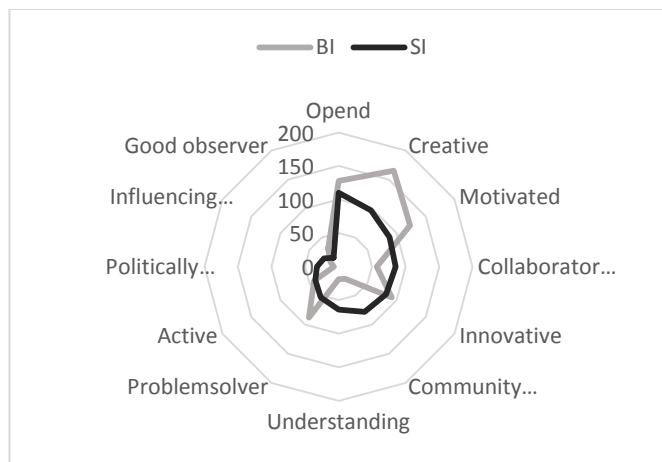


**Figure 5:** Factors hindering business and social innovation, (pcs answer), n=256, Source: own construction based on the survey



Unlike stimulating factors, not the same three factors have been the most significant constraint in the case of hindering factors. In the case of business innovations, the three most hindering factors - in order - were the missing expertise, knowledge (163 pcs.), the short-term thinking (118 pcs.) and the non-supportive attitude of the management (110 pcs). In the case of social innovations, short-term thinking (138 pcs.), lack of expertise, knowledge (137 pcs.), and lack of willingness to cooperate (124 pcs. ) are the most hindering factors. Related to the short-term thinking, we would note that in many cases, social innovation activity ceases with the end of the project financing.

The most interesting question of the research is what are the personality traits whose existence determines the potential role of the innovator. Following structured literature screening, we identified 12 characteristics that can be considered as personality traits that generate business and social innovation. In the questionnaire, we asked the respondents to mark separately the three personality characteristics that help business and social innovation.



**Figure 6:** Personality traits motivating business and social innovation activity, (pcs answer), n=256, Source: own construction based on the survey

In terms of business and social innovations, we expected the biggest difference at this part of the research. Our hypothesis has not been verified because, in different order, but most of the respondents have identified the same personality traits. According to respondents, creativity, openness and motivation as personality traits in both business and social innovations help form the role of innovators. In the case of business innovation activity, innovativeness generally was also mentioned a little bit lagging behind, which can also be observed in the case of social innovations. In terms of business innovation, good problem solving skills are worth mentioning, but empathy, community thinking, influencing skills or political correctness are less decisive. Cooperative skills and community thinking help promote social innovation following the key features closely. The least pronounced features are good observation skills, political correctness, or influencing skills.

**6. Conclusion**

During the research, we sought to identify the relation between business and social innovations. The aim of the study was to map the attitudes of stakeholders towards business and social innovation involved in the innovation process. In the questionnaire, along with knowledge about innovation, we identified the factors that help or hinder the innovation process, as well as identifying the personality traits that are important factors for the role of an innovator. It can be stated that the process of business innovation is a well-known, widely used concept, but the concept of social innovation is not unified, articulated by the users of the concept. In addition to

common features such as enhancing prosperity, engaging society, or meeting community needs, the particular interpretations are different, so a transparent, consistent structure is a basic requirement.

In agreement with the literature, the respondents associated social innovation with a goal concerned to social welfare, but in the case of business innovations, they expected market and operational efficiency improvement.

The most motivating factors for the innovation process, aside from the order, are the same for business and social innovations. In the case of the latter, besides the appropriate expertise, longer-term thinking and openness to new ideas, the need for cooperation appears. It can be stated that respondents rather identify innovation activity in cooperation with social innovations.

In terms of hindering factors, research has shown similar results, besides short-term thinking and lack of expertise that hinder business innovations, lack of cooperation is the main barrier to social innovations.

At the beginning of the research, we thought that there would be a considerable difference in the assessment of personality traits of innovators for business and social innovations. Contrary to our assumption, the personality traits (creativity, openness and motivation) that determine the role of innovators are the same for business and social innovations. In the case of social innovations, this issue of research also proved that cooperative skills are generating further innovations.

In the light of the above it can be stated that innovators are a small group of heroic, energetic individuals who are encouraging change and who are making developments for the community and responding to economic challenges by making economic innovation.

**8. Acknowledgements**

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**Literature**

**Balaton K. – Varga K. (2017):** Social innovation and competitiveness – a literature review of the theoretical work in the field, REVIEW of Economic Studies and Research Virgil Madgearu, 10, No. 2, pp. 27-42.

**Becker, S. W. – Daft, R. L. (1976):** Innovation in Organizations: Innovation Adoption in School Organizations. Administrative Science Quarterly, Vol. 24, No. 1

**Boone, L. E. (1970):** The search for the consumer innovator. Journal of Business, 44, pp. 135-40.

**Bulut, C. et al. (2013):** Social Innovation and Psychometric Analysis, Procedia – Social and Behavioral Sciences 82. pp. 122-130.

**Deák, Cs. - Kiss A. (2017):** Performance and Success of Innovative Projects in Hungary The ISPIM Innovation Forum, Toronto, Canada on 19-22 March 2017.

**Derecskei, A. (2012):** Kreativitás és Innováció, Innovációs verseny - Esélyek és Korlátok: Aula Kiadó, pp. 267-291, 2012.

**Drucker, P. (1985):** Innovation and entrepreneurship, Harper & Row, Publishers, New York

**EC (2006):** Innovation in the national strategic reference frameworks, European Union,

[http://ec.europa.eu/regional\\_policy/archive/innovation/2007/innovation\\_nsrif.pdf](http://ec.europa.eu/regional_policy/archive/innovation/2007/innovation_nsrif.pdf)

**Franz, H.-W. et al. (ed.) (2012):** Challenge Social Innovation, Springer-Verlag Berlin, Heidelberg

**Gábor, D. (1970):** Innovations: Scientific, Technological, and Social, Oxford University Press

**Gloria-Palermo, S. (2005):** Schumpeter and the old Austrian school: interpretations and influences. In: Richard Arena – Cécile Dangel-Hagnauer: The Contribution of Joseph Schumpeter to Economics, Routledge (Taylor & Francis Group), pp. 21-39.

**Introna, L. D. et al. (1999):** The Virtual Organisation – Technical or Social Innovation? Lessons from the Film Industry, Working Paper Series, Department of Information System, London School of Economics and Political Science, <http://www.bioteams.com/Virtual%20Enterprises%20and%20the%20Film%20Industry%20Paper.pdf>

**Kociszky Gy. et al. (2017):** A társadalmi innováció vizsgálatának tapasztalatai és fejlesztési lehetőségei, Vezetéstudomány (Budapest Management Review), XLVIII. évf., 6-7. szám, pp. 15-19.

**Krlev, G. et al. (2014):** Measuring What Matters – Indicators of Social Innovativeness on the National Level, Information Systems Management, Volume 31, pp. 200–224.

**Madarász A. (2014):** Hogyan született a vállalkozó? (How was the entrepreneur born?) [http://real.mtak.hu/15119/1/Madar%C3%A1sz\\_K%C3%BClg.2014\\_7-8.pdf](http://real.mtak.hu/15119/1/Madar%C3%A1sz_K%C3%BClg.2014_7-8.pdf)

**Murray, R. et al. (2010, 2012):** The Open Book of Social Innovation, The Young Foundation, London: NESTA – National Endowment for Science: Technology and the Arts

**Piskóti, I et al. (2012):** Az innovációt befolyásoló tényezők vállalati és projekt szinten in XXVI. microCAD 2012 International Scientific Conference 240. o.

**Rimler, J. (1998):** Kreativitás és vállalkozás (Vizsgálódások Schumpeter nyomában). Közgazdasági Szemle 45, 353-369. o.

Rogers, E. M. (1983, 2003, 5th ed.): Diffusion of Innovations. New York: Free Press

**Schumpeter, J. (1912):** The Theory of Economic Development, tenth printing 2004, Transaction Publishers, New Brunswick, New Jersey

**Smeds, R. (1994):** Managing Change towards Lean Enterprises, International Journal of Operations & Production Management, Vol. 14, Issue: 3, pp. 66-82

**Tóth, Z.-Kiss, A. (2017):** RDI performance in Hungary in the mirror of "European paradox", Közgazdász Doktoranduszok és Kutatók IV. Téli Konferenciája, Budapest, Magyarország : Doktoranduszok Országos Szövetsége, (2018) pp. 639-649. , 11 p.

**Tóthné Kiss A. – Varga K. (2017):** Üzleti és társadalmi innovációk beágyazottsága, kapcsolata – előadás, Nemzetközi ICUBERD Konferencia (International conference on university-based entrepreneurship and regional development: Theory, empirics and practical implementation conference), Pécs

**Varga K. (2017):** Társadalmi innováció az önkormányzatok működésében, In: (szerk. Lipták K.): Társadalmi innováció és felelősségvállalás Észak-Magyarországon, Miskolc, pp. 7-15.

# TECHNOLOGICAL PARKS AND ZONES, BUSINESS INCUBATORS AND CLUSTERS IN BULGARIA AT THE BASE OF INDUSTRIAL COMPETITIVENESS

## ТЕХНОЛОГИЧНИТЕ ПАРКОВЕ И ЗОНИ, БИЗНЕС ИНКУБАТОРИ И КЛЪСТЕРИ В БЪЛГАРИЯ В ОСНОВАТА НА КОНКУРЕНТОСПОСОБНОСТТА НА ИНДУСТРИЯТА

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**Abstract:** *This paper examines the current organizational structures of business in Bulgaria - industrial zones, technology parks, business incubators and clusters with their products, which are based on innovative projects. Made a description of the design analysis of investment projects. The descriptions follow a common structure to facilitate the work of the user, but also to promote the standardization of procedures for analysis and reporting and to facilitate communication between those who propose projects for evaluation and their evaluators. Attached are the results of experimental verification and are statistically lip service given in graphical form.*

**KEYWORDS:** INNOVATION, INVESTMENT PROJECT, METODOLOGY, ORGANIZATIONAL STRUCTURES

### 1. Introduction

Successful development forms of innovation organizations are technology parks and Technopolis. Technology parks (technoparks) are a key tool to stimulate technological innovation in existing enterprises, start-ups or research institutes. Technological parks in the process of its creation in different countries have their own characteristics. Therefore simultaneously with Technology Park meet Science Park, Innovation Centre. All they incorporate core as a university designated area with specific infrastructure that provides the necessary conditions for the transfer of new technologies in the industry, each of these terms has a specific feature [1].

Despite the differences, all structures bearing the name technology parks are typical of a number of common traits that allow them to speak as a special phenomenon. Technological Park is a place where newly created technology-oriented companies can find appropriate intellectual environment and support in starting and developing their business, access to markets, technology, etc.

Innovation clusters depend on global growth markets and are based on intensive use of knowledge. Cluster is a geographical and economic concentration of interconnected organizations, specialized suppliers of products and services associated institutions. This is a set of companies with similar proceedings (in a geographic area or nationwide), but it involves more local governments, business organizations, educational institutions, financial institutions, etc., which cooperate in a common goal. The objective is to achieve higher efficiency in manufacturing, borrowing a sustainable market niche or a new market (local or international), create and launch a new product or new service.

Financing of projects is generally the investment of funds needed for their realization. These funds may have the most diverse source: own resources of the enterprise (depreciation, retained earnings, etc.) borrowings (bank and other loans), international organizations and institutions, the state, etc. co-financing. This is financing, which involves a partnership of two or more institutions, corporations, financial institutions and others in the financial provision of the realization of a project [4, 5].

Usually traditional project investor is the company itself or a corporation that realize it. In the second half of the last century, however, a lasting trend industrialized countries, strengthen the practice in the financing of an investment project to use a wide range of sources, including government. Last rarely provided as direct funding - grants, loans - and often in the form of state guarantees to obtain loans, tax breaks and the like Financing of large investment projects usually implemented by large financial groups (permanent or created specifically for the realization of a project - consortia) or by international institutions and economic entities.

The descriptions in this study follow a common structure to facilitate the work of the user and also to encourage standardization of procedures for analysis and reporting, as well as to ease

communication between those who propose projects, and those who appreciate them. Object of study in this paper are industrial zones and technology parks using innovative projects to improve their competitiveness - a description of the project analysis.

### 2. Exposure

Project financing differs from traditional lending. It can be achieved not only by Commercial Banks (CBs). As participants in the schemes for project funding can participate more Investment Banks (IB), Investment Funds (IF) and companies, Pension Funds, specialized funds of international and regional organizations, leasing companies and others. [2].

Lending by definition be implemented by CB. Only in certain cases, however, where the financing of a project is implemented for the most part by a bank loan, it can talk to a bank (credits) project financing. Moreover, bank loans as a way of investing funds for implementation of projects shall be granted under strict conditions. From the perspective of the banks loans to finance investment projects (IP) are too risky, which is why they are entitled to a higher interest rate and risk premium. This risk is borne by the banks only at sufficiently reliable guarantees for its effectiveness. In many cases they act as entrepreneurs and actively intervene in the development and implementation of the project, not rare and management already in operation site. Often, especially large Commercial Banks, still in contracts for lending to the construction of a particular investment object, reserve the right to convert into shares of the company managing the project, in whole or large part of the amount of loans. This was the reason the project lending to be defined as one of the tools for merging of industrial and banking capital [3].

#### 2.1. Setting goals

It is necessary to consider the local nature of the objectives, as well as the more general significance and impact. For this purpose can be grouped:

- Construction of basic infrastructure for the creation of industrial zones, trade zones and services using innovative projects to improve their competitiveness;
- Construction of basic infrastructure for the planned relocation of productive plants from excessively congested or polluted areas using innovative projects to improve their competitiveness;
- Construction of centers offering services to enterprises and companies of a certain territory (accounting services, financial information, marketing, training ...);
- Creation of centers promoting the creation of new companies and supporting existing ones using innovative projects to enhance the competitiveness (technological parks, business innovation centers, etc.);

- Combination of the above, often in order to provide support to companies and enterprises in a particular segment of the industry and to increase their competitiveness. Functional and physical links of the project with the existing infrastructure system should always be clearly described and defined project [5].

2. 2. Identification of project

To identify the writing of the draft would be useful:

- To identify the serviced area, i.e. the geographical area, the size of the companies that will be attracted (e.g. craftsmen, SMEs, medium and large) and economic sectors.
- To provide basic information such as - the number, size and type of business, type of real services and scientific / technological laboratories, if any;
- Provide the following engineering data:
  - Location and area (km<sup>2</sup>) of equipped area and the breakdown of land;
  - Number and covered area (m<sup>2</sup>) of warehouses, stores, office space, exhibition areas, etc.;
  - Internal viability and mobility (roads and railways) and their links with external systems; features of possible ports, heliports, etc. ;
  - Internal networks and systems, e.g. aqueducts, drainage systems, sewage systems, electricity, lighting, telecommunications systems, security, etc., attaching data and layout;
  - Number and floor area of public buildings (real services, laboratories, logistics, canteens, telecommunications centers, etc.);
  - Significant technical elements, such as specialized laboratories, multimedia services centers, etc.

2. 3. Feasibility studies and analysis capabilities

A comparison with the previous situation (without the project) and possible alternatives for satisfying the same demand.

Main question of feasibility studies and analysis of the options is:

- Assessment of demand from existing companies to relocate in the serviced territory;
- Rate of emergence of new companies;
- Demand and dynamics of real services;
- Elements of the environment;
- Innovation.

The options analysis should consider global alternatives, e.g. increased funding direct to companies for the same purpose (relocation, purchase of real services, technological innovation, new production lines or newly constituted companies, etc.)

2. 4. Financial Analysis

Financial analysis must be conducted even if the services are totally free (financial rate of return is negative). The analysis should measure the net cost of public finances and to make a thorough comparison with other similar investments.

The financial analysis includes:

- *Financial inflows:*
  - Rental costs;
  - License costs;
  - Cost of land;
  - Costs of storage;
  - Expenses selling prices of services (water, electricity, drains and purification, storage, logistics, etc.)
  - Expenses for real services.
- *Finance costs:*
  - Costs for goods and services necessary for the operation of infrastructure;

- Costs for the production of real services.
- Time horizon: at least 20 years.

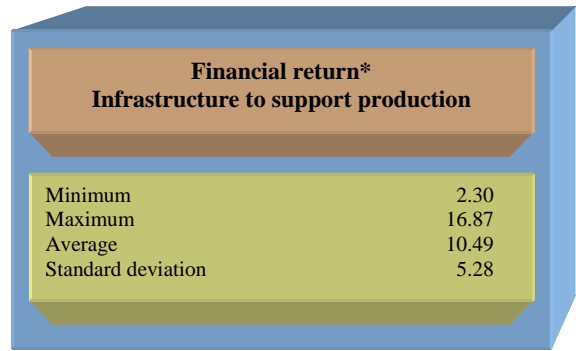


Fig. 1 Financial return\* Infrastructure to support production  
\* Sample data: 4 major projects out of 14 in the sector included in the sample were 400 projects [5].

2. 5. Economic Analysis

To the elements outlined in the financial analysis should be evaluation of the main social costs and benefits. For financial and economic analysis we can make compared between two situations - with and without investment.

The analysis must take into account:

A) Social benefits: better positions on the market - for existing companies, distribution of entrepreneurial knowledge and skills among companies - beneficiaries and externally, retraining, impacts of various production factors on employment and incomes, the emergence of new productive companies, the emergence new private companies for services, etc.

B) Determine the amount of social benefits: one of the possible approaches that can be adopted in some cases, is to divide potential companies - beneficiaries of the serviced area by size and sector of activity. Then you can assess the benefits for each class companies, using, for example, increased added value thanks to its advantageous location (e.g. savings of transport costs, greater penetration of the market, which was previously hardly attainable, the effect of possible promotional activities of the new exhibition space, lower costs for basic services, etc.), or the availability of real services (e.g. a good market position due to marketing service, better penetration and cutting costs through telemarketing, technological improvements or new production technologies, improved professional level thanks to training, etc.).

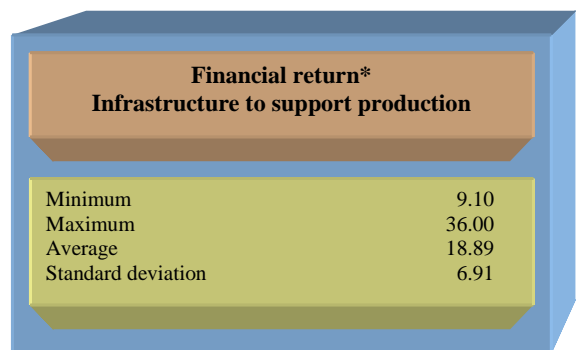


Fig. 2 Financial return \* Infrastructure to support production  
\* Sample data: 4 major projects out of 14 in the sector included in the sample were 400 projects [5].

The economic costs of raw materials and the land used for construction of the site should be assessed according to the loss to society by the diversion of these resources from alternative, better ways to use them. Similarly must evaluate personnel costs.

The cost of the environment must also be quantified (pollution of soil, water and air pollution, damage to the visual impact, noise,

waste, etc.), and possible overloads urban and transport congestion caused by realization of infrastructure. It should, however, take into account that since the relevant impacts will increase in the area surrounding the new infrastructure, they should decrease in the rest of the serviced area, the global effect - which precisely must be taken into account in the analysis - may be positive or negative (i.e. control systems can be more efficient, etc.).

### 2. 6. Other elements of assessment

Social costs can be measured by physical indicators, directly or indirectly related, and it is possible to calculate the cost-effectiveness (cost/efficiency), which are associated with social costs.

Use multi-criteria analysis and other evaluation criteria, and should discuss some indications on other evaluation criteria, particularly in relation to environmental impact, innovation and technology development.

### 2. 7. Sensitivity Analysis and Risk Analysis

Uncertainties and risks regarding trends in the variables are important and part of the considerations in the evaluation of investment projects.

Key factors are:

- Initial lack of flexibility;
- Difficulty in forecasting the real rate of penetration in the serviced area, both in terms of moving companies (in some cases relocation is accelerated by favorable policy of territorial planning) and development of new companies.

The sensitivity analysis and risk analysis should take into account:

- Cost of the investment;
- Application rate in the area;
- Costs for certain input factors of particular importance (labor, outsourced goods and services needed for production of real services);
- If quantified pace of development and premature closure of new businesses.

### 3. Conclusions

Descriptions made in this study follow the general structure for the development of investment projects for enterprises with a modern organizational structure, such as industrial zones, technology companies, business incubators and clusters. These structures use innovation to increase their competitiveness. Facilitates the work of the user and promote the standardization of procedures for analysis and reporting. Ameliorated communication between those who offer innovative projects and evaluators of these projects.

Object of study are the description of the design analysis of innovative investment projects for industry, in particular for businesses and companies aimed at:

- Increasing the competitiveness of the market;
- Increasing market niche;
- Introducing technical innovations and inventions;
- Improve the standard of living and working.

### References

- [1] Damianov, D., T., Panayotova, Organization of Competitive Engineering in Industrial Companies (Organizacia na konkurentniq injenering v industrialnite firmi), 2007, ISBN 954-20-0369-4.
- [2] Petrova, D., N., Nenov, S., Kartunov, The budget deficit in Bulgaria today, „Research and Development in Mechanical Industry“ RaDMI 2014, 18-21 September 2014, Topola, Serbia, SaTCIP Ltd., ISBN 978-86-6075-047-3, Volume 1, pp. 545-548.
- [3] Petrova, D., Bulgaria’s banking system now, „Research and Development in Mechanical Industry“ RaDMI 2014, 18-21 September 2014, Topola, Serbia, SaTCIP Ltd., ISBN 978-86-6075-047-3, Volume 1, pp. 549-551.
- [4] Petrova, D., Innovation Strategy of the Republic of Bulgaria and Measures for Its Implementation, Nacionnalnu konferenciju sa međunarodnim učešćem “Menadžment, sport I turizam” MASTA 2013, 20-21 decembar 2013, Banja Luka, Republika Srpska (Bosna I Hercegovina), ISBN 978-99955-22-58-2, pp. 208-212.
- [5] [www.europa.org](http://www.europa.org)

# FUNDAMENTAL NATURE OF LOGISTIC PROCESSES AND OPPORTUNITIES TO DIGITALIZATION

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**Abstract:** *Industrial development has brought about qualitative changes in the very foundation of innovation and automation. The distinctive features of enterprises with such a type of production are becoming increasingly blurred by the growing tendency for global industrial development. They become heavily dependent on the pace of development of automation, industrial technologies, communications and ever more determined by the factors that most affect and shape the trends of that development. It is therefore of utmost importance to carefully define the distinctive features of modern logistics processes that form the foundation of the respective digital development policies, which is also the primary objective of the proposed paper. These policies are undoubtedly enforced by the very evolution of technology and are likely to define the new directions of cyber development.*

**Key words:** LOGISTICS, LOGISTICS PROCESSES, DIGITALIZATION, DIGITAL DEVELOPMENT

## 1. Essence of the term “Logistics”

This section aspires to explore the applied, theoretical and methodological aspects of logistics, i.e. the information provision of the logistic process, full awareness of the practices and methods for organising and managing the information flows within the logistics systems, the basic functional principles of the logistics information systems and the modern information and communication technologies in logistics, as clearly defined by various authors.

Logistics is necessary both for the economic growth of the country and for its prosperity. It can also be described as an integral part of the supply chain management as it allows for the proper planning, implementation and strict control over the efficient and effective movement of the flow and storage of goods and services. Maintains and joins or links the information between the point of origin and the point of consumption.

The word “logistics” was initially used as a military term to refer to the delivery of consumable items to those serving in the army. Nowadays, the concept encompasses activities starting from the business, with its materials, commodity and information flows, raw materials and terminating with the end-user. This is an area of growing importance, developing in line with the local and international trade. Logistics, in a general business sense, is the science that is concerned with the organisation of the management of the process of popularization and promotion of goods and services by suppliers of raw materials to consumers, the entire work related to the distribution of products, goods, services, inventory management and provisions, development of proper infrastructure to enable unimpeded movement of goods.

As for the company, logistics addresses problems concerning the coordination of wholesale purchases, sorting and splitting of bulk shipments, transportation, storage and sale of goods. Logistics provides for the accounting and optimisation of the commodity-financial flows that arise in the course of the company's business activities.

The definition of logistics, being employed by different users and addressing diverse needs results in minor variations. Its path goes through the strategic concept that outlines the business model of the company and along to the designation of transportation or description and formation of the production process.

In other words, the customer receives the desired product in the right place, at the right time and at the right price. Logistics has gradually developed into a key factor for the enterprise that is associated with competitiveness and environmental sustainability and brings about reduction in business expense/reduced business costs. The customer and the market have attained a central position in logistics, i.e. the customer's needs are not simply addressed but completely fulfilled. On the whole, this is a platform, a resource base that facilitates the occurrence of strategic actions and gaining considerable competitive advantages for the enterprise.

The logistics process comprises the following parts: materials supply, production and distribution. Distribution covers transport,

management and storage. Storage is also considered as a part of the materials supply and production.

There is a growing need for logistics services among manufacturers and trading companies due to the increased globalization of business and pressure of competition. The primary goal is to make the products and services easily and readily available on the market. All in all, the logistics service provider industry ranges from several substantial representatives offering basic transport services to long-established market leaders with a wide range and scope of logistics services (e.g. one-time purchases) to niche companies with a more diverse portfolio of interests [1,2].

The new service strategies have been triggered by the transformation of the scope and characteristics of the services offered by the service provider. Such an intense interest and accelerated development of more personalised services arises from the strong desire to strict customer compliance requirements and improved service levels [3,4]. The transformation of the scope and characteristics of the services offered by service providers trigger the development of new service strategies. These novel strategies are contingent upon the initial base of the capabilities which is likely to have a strong impact on the subsequent stages of the company's. The trend towards higher value added services afford providers the opportunity not only to differentiate their business from the competition but also to strengthen relationships with their customers.

As a result of the improvement in personalized services, the pressure applied to the industry of logistics service providers is characterised by strategic influence in terms of market coverage, enhanced level of service and increased flexibility to respond to changing customer requirements. For example, the so-called “green logistics” has become one of the basic requirements in our time.

Research in the field of green supply chain management has expanded significantly over the last few decades in view of the growing importance of the environmental components in the management of these chains. “The green supply chain” is a broad concept that takes into account different approaches adopted by the companies in their work with the respective supplier and/or customer to boost the environmental performance of their operations.

According to some authors, such an approach has two main objectives:

- Consistent implementation of certain environmental performance criteria among participants throughout the supply chain and fostering responsible corporate environmental behaviour;

- Helping suppliers become cognizant of the full significance of dealing with immediate environmental problems and actively supporting them in setting up their own initiatives for improvement [5,6,7].

Some authors share the opinion that investing in environmental initiatives is environmentally sound and beneficial to the business, as it increases the efficiency of the business itself by saving

resources, eliminating waste and increasing productivity. Such initiatives can also open the way for major competitive advantages in the areas of innovation and operations [8]. The “Green” initiatives are of great importance for logistics transport. Logistics providers are gradually transforming the scope of their services by offering a shift from a single business to a business model based on a wider range of services. With such a process in progress they seem quite enthusiastic about adopting eco-friendly transportation options, along with some non-transportation-related activities or a Practitioners and scientists tend to interpret the concept of Logistics in their own way. There are some who believe that Logistics is a sphere of economics, that characterizes the interaction between the supply, production, distribution, demand and consumption. There are others who define Logistics as a new scientific direction referring to the development of rational methods for managing material and information flows in the process of meeting the demand for goods and their supply to the consumer with minimal cost of resources.

**Logistics service** - non-automated process and without the use of information systems and technologies

The difficulty in clarifying the concept of Logistics lies in the fact that it comprises a multitude of directions and areas, wherefore even the highly-qualified professional cannot be an expert in all or most of these directions concurrently.

Author	Definition
<b>FLOW-ORIENTED LOGISTICS: FORMULATION OF THE DEFINITION</b> <b>PFOHL, H.-Chr.</b>	Logistics refers to all activities to plan, manage, implement and control the product transformation in space and time and the associated transformations with respect to product quantities and types, product characteristics of the services and logistics determinations of the products. Through the joint action of these activities, the product flow must be activated by connecting the point of departure to the point of destination (receipt) as efficiently as possible.
<b>The seven “R’s” of logistics</b>	The seven “R’s” defines Logistics as ensuring the availability of the right (appropriate) product, in the right quantity, in the right place, at the right time, with the right quality, for the right customer, at the right (optimal) costs.
<b>Council of Logistics Management (CLM)</b>	Logistics is the process of planning, implementation and control of the efficient and cost-effective movement and storage of raw materials, semi-finished and finished products accompanied by the relevant information from the point of departure to the point of destination (receipt) in full compliance with the customer requirements.
<b>European Logistics Association (ELA)</b>	Logistics is the organisation, planning, control and implementation of a product flow from its development and from the purchase through its production and distribution to the end user in order to meet market requirements with minimum cost and minimum use of capital.
<b>KLAUS, P.</b>	Logistics is a specific way of perceiving by way of interpreting economic phenomena and interconnectedness as flows of objects moving steadily through chains and networks of activities and processes in an effort to optimise them in terms of cost reduction and value increase as well as to enhance their ability to adapt to changes in consumer needs and surrounding environment.
<b>DANDY</b>	Logistics is the management of the product flow throughout the entire enterprise from the moment the order arrives to the moment when the customer receives the finished product as cost-effectively for the enterprise itself as possible.
<b>BAUMGAR TEN, BOT, HAGEN</b>	Organisational logistics covers planning, management, implementation and control of all material and information flows within and between the enterprises from the customer to the provider. The supply chain, production, distribution, reverse and transportation logistics are critical sub-domains of logistics involved in all process chains and process revolutions.
<b>MAGEE, J.F.</b>	Logistics refers to the management of the flow of materials and products from the source to the manufacturer. The logistics system includes the total flow of materials – from the supply of raw materials to the delivery of the finished products to the end users, although traditionally a given company takes direct control over part of the overall logistics system for its products.
<b>LIFE CYCLE ORIENTED FORMULATION OF THE DEFINITION OF LOGISTICS: Society of Logistics Engineers (SOLE)</b>	Logistics is the right management which, during the life cycle of a product, ensures efficient use of resources and adequate capacity performance of logistics elements throughout all the

combination of them. Introduced have been approaches based on the development of an integrated package of initiatives designed to improve the environmental sustainability of services that logistics companies provide to their customers [9,10].

**Logistics – well-established terms and definitions**

The global economic literature provides myriads of definitions of the concept of Logistics. And yet, it eludes any precise or specific definition. The ambiguity is ascribed to the different perspectives from which it can be applied in practice.

Logistics cannot be a matter of concern only to the manager or the Marketing Specialist. It touches upon a new model of development, where technical and economic opportunities are used reciprocally and much better than ever before to meet the requirements of the market.

Nevertheless, among the huge variety of definitions, there are three descriptions that can be set apart:

- flow-oriented formulation;
- (product) life cycle oriented formulation;
- service-oriented formulation.

Compiled in Table 1 is part of the most widely used definitions and their respective authors [11].

**Table 1. The most widely used definitions and their respective authors**

	phases of the life cycle, so as to ensure effective resource management by timely intervention in the system.
<b>SERVICE-ORIENTED FORMULATION OF THE DEFINITION OF LOGISTICS: PFOHL, H.-Chr.</b>	Logistics is a process of coordination of all intangible activities, which, for the implementation of a given service, should be performed as cost-effectively for the customer as possible.
<b>BLAGOEV, V.</b>	Logistics includes all the company’s functions related to the storage, transportation, cutting, packaging, receiving, dispatching and customer service, including planning these activities in such a way as to ensure customer satisfaction while achieving company’s goals.
<b>SERVICE-ORIENTED FORMULATION OF THE DEFINITION OF LOGISTICS: PAVEL DIMITROV</b>	Logistics is an integrated (interconnected) management of material (and related information) flows from the point of their inception through all the phases and stages of movement to the end-users, in order to ensure the required level of customer service in the most efficient and cost-effective way. From the point of view of the individual company, the application of the logistics concept means an integrated management of the three phases of the movement of material flow – incoming, internal and outgoing, in respect to the three areas of company management – supply, production/operations and distribution and further inclusion in the process of integration of suppliers (and their suppliers/customers) and their customers/across the total or part of the so-called supply chain.
<b>SIYKA DEMIROVA</b>	Conventional logistics – a logistics activity, which is managed centrally, and whose separate components are unable to communicate independently with each other. Cyber-logistics – a decentralised logistic management activity, in which the individual components can make independent decisions and the entire logistics process is subject to the cyber-physical requirements of the system. Digital logistics – the complete logistics process is digitised and its proper functioning is impossible without a digital foundation.

Applicable as well are the following definitions:

**Communication logistics** – the unit connecting, by means of communication, the company with the customer provides information about the price, delivery time, informs the customer if the contract expires, etc.

**Information logistics** –another name for information system. The customer calls the agent, the agent looks into the CRM system database with all the information and documents that relate to the customer, then looks into the information system to see the product’s price, its characteristics, etc. Information logistics strives to ensure the achievement of the key logistics operational objectives on the basis of constant monitoring and maximum impact of management on logistics processes, through relevant information provision [12]. The information most necessary for the attainment of the above objectives unfolds gradually while performing various logistics operations accompanies the movement of material flow at all stages of its occurrence. From this perspective, the information

flow is regarded as a flow of information with fixed start and end points.

There is a **logistics work-flow system** featuring the tariffs that are automatically transferred to the information system.

**Electronic logistics (e-service)** – based on the use of any electronic information systems, distribution, financial, etc.

**Communication and information logistics** are sub-components of e-logistics.

**Financial logistics** discloses details about the customer's account, payment due date, etc.

**Supply** – the accepted definition of the common objectives of logistics functions states that the organization should obtain the requested material resources in the right quality and quantity, at the right time, in the right place, by a reliable supplier, providing excellent customer service (both before and after the transaction), at a bargain price.

All in all, the flow-oriented formulation of logistics is viewed as the most common and widely applied both in science and practice.

#### **Other terms used in logistics**

**Knowledge** is information that has been processed and perceived by a person or group of people.

**Information logistics** – the science for the application of methods for collecting, processing, storing and disseminating information in industrial and economic systems and their environment based on rules of logistics (strengthening the importance of information in the right quantity, at the right time, in the right place and at optimal price).

**The information standards** describe the structure and type of documents to be transmitted over the information network.

**The information process** is a process in which information is considered a primary object with a certain sequence of changes.

**The information** is to be obtained subsequent to appropriate processing of data that reveal the content of numbers, symbols and words that give details on the event.

**The communication standards** determine the characteristics of signal reception, signal transformation and the speed of data transmission.

**Logistics information system (LIS)** - a coherent set of proper software, hardware and operational rules for integrated information space with the intention of ensuring the efficient and effective functioning of the logistics chain.

**Logistics information flow** – refers to prevailing or organised within the frameworks of LIS information about the traffic in a particular direction provided that these data have a common source and a common receiver (for example: a set of data transmitted from one unit of the system (orders-source department) to another unit (for example, an industrial department - addressee).

**Information flow** - movements in any medium of data expressed in a structured form.

**Electronic business** - the implementation of most business functions by electronic means (in particular through e-commerce via online network services).

**Timeliness** - logistics information has to enter the management system within a reasonable time frame as required by a variety of logistics technologies, especially those based on the concept of "just-in-time". Timeliness of information is of paramount importance for almost all complex logistics functions. In addition, myriads of tasks in the area of transport, operational management, order and inventory management are processed in real time. The requirement for timely receipt and processing of information is carried out through advanced logistics technologies for storage, barcoding, electronic data exchange.

**Orientation** - Information in the logistics information system should be steered towards proper identification of additional opportunities for improving product quality, services, reducing logistics costs. The methods adopted for obtaining, transmitting, filing and pre-processing of information should help identify "bottlenecks", resource-saving reserves, et al.

**Flexibility** - the information circulating within the logistics information system is to be adjusted to become easily applicable to the requirements of specific users.

**Data** - basic information obtained as a result of a direct observation of an event within an object in the form of numbers, symbols, characters and words.

**Information logistics** - – the science for the application of methods for collecting, processing, storing and disseminating information in industrial and economic systems and their environment based on rules of logistics (strengthening the importance of information in the right quantity, at the right time, in the right place and at optimal price).

In conclusion, it can be inferred that in practice there are varied definitions, numerous terms and concepts of logistics, which, in essence, bear the characteristic features of the type, purpose, nature and trends in the development of this process.

#### **Conventional logistics**

Conventional logistics differentiates between the following concepts and definitions for the main components of logistics in terms of the scope, structure, the way in which the matter is approached, the function it serves, etc.

#### **Logistic flows, Logistics Systems**

**Logistic flows.** Established in conventional production principles are the following definitions for flows running in parallel: material flow, information flow, financial flow.

**Material flows.** The most important ones are the material flows of goods and raw materials. Second in importance are the financial flows or the provision of the material flow with financial support. The information is assigned the secondary role, which is to support and maintain the physical process of the movement of goods from the supplier to the consumer, but only as accompanying information.

**Information flows.** With regard to the corporate activity, the flow of information is a set of circulating messages within the corporate system, and also between the internal system and the external environment, an essential prerequisite for the control and management of core and ancillary processes and operations. Of course, the auxiliary information system, predominant or aligned within the information system, pertains to the traffic in a particular direction provided that these data have a common source and a common receiver.

**Modules** are system blocks for information processing (for example, taking orders or allocating inventories by order). Data files are the infrastructure of the information system where information is stored, divided into functionally homogeneous groups, such as: data management and input is a type of interface through which the logistics system receives information from external sources: from those who make decisions within the company itself, or from other companies. The reports contain information about logistics operations and cross-functional collaboration. Communication channels (information exchange channels) ensure the interaction of the elements of the information system both internally among themselves and externally with the outside world.

#### **Affiliation of operations, processes and activities to logistics**

##### **Signs of identity**

It is particularly necessary to allocate information that contributes to the main strategic resource of logistics in the "supplier-consumer" model. The use of modern computer processing models or techniques makes it possible to reduce costs due to a more efficient management of information flows, increased speed and coordination. The term "information resource" is considered an economic category. Information resource management means:

- assessing the needs of information at every level of the logistics system and in each function of logistics management;
- research and rationalization of documentation, organisation of effective exchange of electronic documents;
- overcoming the incompatibility of typical data;
- creating a data management system.



**Creating a digital environment.** The above-mentioned operations, processes and activities can all serve as a sound basis for creating optimum conditions for the digitisation of the logistics process. It follows from here that a process identity environment should be created both horizontally and vertically. In practical terms, this requires a precise identification, differentiation and grouping of affiliated operations, or marking off those operations and processes that mostly serve logistical purposes. This activity can be envisaged as the first stage of the digitisation of logistics systems. The second stage should be the construction of a system that would promote and enhance the digital dimensions of logistics processes.

**Conclusion**

Finally, it can be concluded that digitisation of logistics systems is a complex issue closely related to and dependent on the digitisation of other production activities and processes. This also implies the need for the gradual digitisation of logistics processes and systems, namely:

- First, determining the affiliation of operations and processes to logistics activities;
- Digitisation of logistics processes and systems.

**Bibliography:**

1. Berglund, M., van Laarhoven, P., Sharman, G. & Wandel, S. (1999), "Third-Party Logistics: Is There a Future?", *International Journal of Logistics Management*, Vol. 10, No. 1, pp. 59-70
2. Dragomirov N., Big data in Logistics – definition and sources, *Vanguard scientific instruments in management*, vol. 11, no. 2, ISSN 1314-0582, 2015
3. Lieb, R. & Bentz, B.A. (2005) "The Use of Third-Party Logistics Services by Large American Manufacturers: The 2004 Survey", *Transportation Journal*, Vol. 44, No. 2, pp. 5-15
4. Abdikeyeva N.M., *Information Management*, Moscow: INFRA-M, 2010
5. Damyanov D., *Innovations - technology, organization, management, financing, politics*, Ed. Primax, Rousse, 2013
6. Nawrocka, D., Brorson, T., & Lindqvist, T., (2009) "ISO 14001 in environmental supply chain practices", *Journal of Cleaner Production*, 17, pp 1435–1443
7. Ninlawan, C., Seksan, P., Tossapol, K., & Pilada, W., (2011) "The Implementation of Green Supply Chain Management Practices in Electronics Industry", *Proceedings of the International Multiconference of Engineers and Computer Scientists*
8. Damyanov D. *Trends in Industrial Development and Automation of Discrete Production Processes*, *Scientific Papers from Conferences ADP*; Sozopol, ISSN 1310 - 3946, 2011
9. Porter, M.E. & van der Linde, C. (1995), "Green and Competitive", *Harvard Business Review*, Vol. 73, No. 5, pp. 120-134
10. Damyanov D., et al., *Innovation base of industrial development and tendencies in the automation of discrete industries*, *Collective Book-CARD*, TU-Sofia Publishing House, 2015
11. Dimitrov P., et al., *Logistics Systems*, University publishing house, Stopanstvo, Sofia, 2010
12. Dimitrov I., et al., *Logistics*, TU-Varna, 2012

# MODERN INFORMATION SYSTEMS FOR AUTOMATED MANAGEMENT OF AUXILIARY PROCESSES

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**Abstract:** In parallel with the computer technology and the developed models for optimization of the basic and auxiliary processes it is common to apply different methods of organization and automation of these processes. Based on state-of-the-art computer technologies, a new generation of information management systems has been developed. They have been designed to meet the new requirements both to the logistical nature of this information and to the organization approaches of other ancillary information systems. The goal of this article is to approach the nature, role and benefits of the application of automated systems for managing ancillary information systems in practice.

**Keywords:** COMPUTER TECHNOLOGIES, AUTOMATION OF AUXILIARY INFORMATION PROCESSES, INFORMATION SYSTEMS

## 1. Introduction

Parallel to computer technologies and developed models for optimization of logistic processes is common to apply different methods of organization and automation of logistic processes. They have been designed to meet new requirements of logistic nature.

## 2. Essential modern information management systems. Features of the information in these system

Information systems in auxiliary activities can manage material flow either in one single company, but can facilitate the organization of ancillary processes, such as the logistical processes on the territories of the regions, countries and even a group of countries (typical of the EU) [7, 8, 9]. Examining and determining the types of information systems in logistics is shown in Fig.1.

At a company level, information systems are divided into three groups:

- Planned (planned).
- Dispersive (dispatching).
- Executive (operational).
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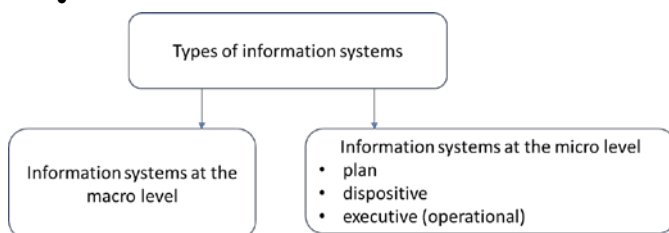


Fig.1: Types of information systems

These information systems serve to the auxiliary processes and differ in both functionality and type of subsystems. Therefore the functional subsystems differ according to the tasks and technical information, etc. [1,3,5].

Looking at the details of the specific information systems for management, we will find out that:

### Planned information systems

These systems are set up on high level of governance and serve to make long-term strategic decisions. Typically, tasks such as:

- Creating the logistics chain and optimizing its links.
- Planning of production (basic, auxiliary and other processes).
- Management of technology (manufacturing, transport, etc.).
- Management of inventories and reserves.
- Management of other processes related to logistics.

### Disposable information systems

These systems are set up on lower level of management, such as warehouses or workshops, and serve to ensure more seamless operations of logistics systems. The following tasks can be addressed and solved:

- Detailed inventory management (storage);
- Management of in-house and warehouse transport;
- Selection of order loads and their acceptance and reporting.

### Executive Information Systems

They are set up in low administrative or operational management. The processing of information depends on the speed which enters the computer system. This is the so-called real-time model that allows you to observe all necessary information about goods movement then the manager can make administrative and control actions. These logistics information systems can solve different tasks related to material flow control, operational management of production services, material and commodity movement management, etc. These characteristics of the logistic information systems are of a different nature in the context of their functions as subsystems [4].

Creating information systems for materials management at several levels, is always associated with considerable costs. Especially in the field of software development, which on the one hand should ensure the flexibility of the system and on the other - higher degree of integration - in this context, in setting up management systems. In this area, consideration should be given to the use of relatively inexpensive standard software with adaptation to local conditions [2,6,10].

At present, general software packages have been created. But they are not applicable to all types of ancillary information systems. This depends on the level of standardization of the tasks.

### Corporate character of these information systems

Effective management of information flows is very important to ensure an appropriate level of implementation of operational operations and proper customer service. Key areas for the use of information flows in these are: timing of delivery of goods, the management of warehouse levels, the reporting of the receipt and execution of orders, the control of consignments and their transportation, not at least the choice of the supply chain [11,12,13].

All of these processes respond to the scope and competence of so called corporate logistics. Therefore, clear, accurate and timely information should satisfy the customer's requirements for quality information services based on the following principles:

- Accuracy of the information
- Ensure information traceability.
- Easy access to information

Consequently, the automated information system for management of ancillary activities is, a new type of system. It is characterized as a system of interconnection of computer technologies with auxiliary processes. This system in combination with the information system, which provides correct information for organizing and implementing the planning and execution of ancillary operations form and define the essence of modern information management systems.

From a functional point of view, these system is focuses on a four structures:

- First Level - performing specific operations: receiving orders, delivering products, accounting for the products, preparing freight, accepting inputs, warehouse operations, etc .;
- Second level - accounting and control issues: equipment management, accounting, product transport control, accounting operations on accounts and issues of funds on accounts, etc .;
- Third level - solving analytic issues: using logistics from the point of view of assisting the marketing operations (sales promotion), forecasting the receipt of orders and forecasting the possibilities for their implementation, financial planning (including logistics costs);
- Fourth level - solving strategic problems: planning of operations at company level, changes in the structure, definition of priority directions in the logistics work for the future.

There are three levels of application

- macro level, external environment of logistics;
- micro level, internal environment of logistics
- Company level, level of communication with other companies.

Logistic system has been used to:

- integrate logistics planning
- integrate logistics operations
- developing a logistics strategy.
- integration of the information technologies Integration of information technologies with partner companies;
- Analysis of labor productivity in logistics and quality of logistics operations.

Using computer technologies the user has access to all kinds of databases. Special sets of data can be created in the field of logistics planning, company logistics policy, economic performance and cost accounting.

**Requirements for the introduction of modern automated management information systems**

The goal of building information systems is to acquire the ability to manage, control, and plan the flow of materials and services, to ensure that information effectively supports these processes, the construction of a automated information system must be based on the basic logistics principles and organizational rules as follows:

- The fullness and validity of information. The logistics information system must provide information on the location, type and completeness necessary to perform the relevant logistics functions and operations. The decision-maker must have the necessary and sufficient information to make the right and accurate decisions.
- Transparency. Transparency of outgoing information is essential for making the right decisions. For example, information on the level of reserves in the distribution network in today's logistics systems does not allow more than 1% of errors or uncertainties in making effective decisions about physical distribution, stockpiling and customer satisfaction. Of great importance is the accuracy and reliability of output data for forecasting demand, planning material resource requirements,
- Just in time. The logistics information must enter the management system in a timely manner, requiring a variety of logistics technologies, especially those based on the "just in time" concept. In fact, timeliness of information is important for all complex logistics functions. In addition, many tasks in the field of transport, operational management, order management and inventory are handled in real time. The requirement for timely receipt and processing of information is through modern logistics technologies for storage, barcoding, electronic data exchange.
- Orientation. Information in this information system should be geared towards identifying additional opportunities to improve product quality, services, and reduce logistics costs. Methods of receiving, transmitting, displaying and pre-processing information should help to identify bottlenecks, resource-saving reserves.
- Acceptable data format. The format of the data and messages used in the computer and communication networks of the information system should make maximum use of the technical capabilities (memory capacity, speed, bandwidth, etc.). The types

and forms of the documents, the location of the requisites of the paper documents, the size of the data and other parameters must facilitate the computer processing of the information. In addition, information compatibility between the computer and telecommunication systems of intermediaries and other users in the form of data in an information system is also needed.

**3. Economic benefits of introducing logistics information systems**

The sum of the most important economic benefits from the introduction of automated information systems are as follows:

- Reduce auxiliary time. Thanks to the improved information flow, it is possible to optimize the subsequent transport, warehousing, loading and unloading and production processes in advance and to shorten the time for their implementation.
- Reduce inventory as a result of risk reduction. Timely and reliable information reduces the risks associated with stockpiling. Stocks of raw materials, semi-finished products and finished goods can be partially replaced by stock information or on the way to it.
- Rational use of resources. Timely information on the implementation of logistics channel processes and the state of logistics infrastructure enables more rational use of production factors, such as transport routes, means of transport, loading and unloading facilities or staff.
- High quality of the auxiliary process. By transferring data from one information system to another, the need for multiple data registration is eliminated. This can reduce paper consumption and avoid sources of error,
- Reduce resource consumption. By transferring data from one information system to another, the need for multiple data registration is eliminated. This can reduce paper consumption and avoid sources of error,
- Reduce the cost of data processing. Once registered in the system, the data can be used for calculation and updates.
- Creating a better environmental environment. The introduction of an automated information system will reduce unavoidable environmental pollution and create the conditions for its improvement.

**Conclusion**

It can be concluded that automated assistive management systems are already from a new generation. They are characterized as systems of interconnection between computer technologies with the reality of the auxiliary processes. It is such a system in conjunction with the information system formed and define the essence of contemporary automated systems management support processes. The economic benefits of their construction are proven.

**References**

- [1] Chukalov,K., Researching conditions for transferring conventional technologies to requirements of Industry 4.0, Bulgarian Journal for Engineering Design, Issue 37, 2018, pp 89-94
- [2] Damianov D., Demirova S., Principles of designing automated logistics systems - hybrid component of cyber-physical systems, International Conference on High Technology for Sustainable Development, HiTech, 2018
- [3] Damyarov D., Innovations - technology, organization, management, financing, politics, Ed. Primax, Rouse, 2013
- [4] Damianov E. Trends in Industrial Development and Automation of Discrete Production Processes, Scientific Papers from ADP Conferences; Sozopol, ISSN 1310 - 3946, 2011
- [5] Demirova S., Industrial Information Technology - A Revolutionary Factor In Logistics, Acta Technica Corviniensis - Bulletin of Engineering, Tome X, 2017, Fascicule 4 (Oktober-December), pp.25-28, ISSN 2067-3809
- [6] Demirova S., Integration levels of company logistics in intelligent manufacturing, International Conference on High Technology for Sustainable Development, HiTech, 2018
- [7] Grigoriev M.N., Information systems and technologies in logistics, 2006

- 
- [8] Guo Y, Qu J., Study on Intelligent Logistics Management Information System Based on IOT and Cloud Computation in Big Data Era. *Open Cybernetics & Systemics Journal*, 2015, 9(1):934-941
- [9] Hofmann E., Marco Rüsçh, Industry 4.0 and the current status as well as future prospects on logistics, *Computers in Industry*, Volume 89, August 2017, Pages 23-34
- [10] Krieger W., Zukünftige Informationssysteme in der Logistik, *Informationsmanagement in der Logistik* pp 201-202, 1995
- [11] Nikolova.L., (2018) Development and Application of Systems for Resource Planning ERP/ASP. *Innovations in Discrete Productions*, Issue 1/2018, Sofia, ISSN 1314-8907, pp.15-17
- [12] Tomov P., Increasing the Efficiency of Automation of Production Processes by Reporting the Parameters of the Parts' Flow. *TEM Journal*, 2017, 6(3), p. 484-487
- [13] Tomov P., "Innovative solutions for the automation of discrete production engineering" 12th International conference on "Standardization, prototypes and quality: a means of Balkan countries' collaboration", Kocaeli, from 22nd to 24th of October, 2015
- (14) Tomov P., Possibilities for Implementing Production "Automation Islands" in an Automatic Production System, *International Conference on High Technology for Sustainable Development, HiTech 2018 – Proceedings*, Publisher: Institute of Electrical and Electronics Engineers Inc. ISBN: 978-153867039-2, DOI: 10.1109/HiTech.2018.8566356
- (15) Dimitrov, L., Purgic, S., Tomov P., Todorova, M Approach for Development of Real-Time Marshalling Yard Management System, *International Conference on High Technology for Sustainable Development, HiTech 2018 – Proceedings*, Publisher: Institute of Electrical and Electronics Engineers Inc. ISBN: 978-153867039-2, DOI: 10.1109/HiTech.2018.8566369

# ANALYSIS AND ASSESSMENT OF THE FINANCIAL EFFECTS OF THE INNOVATIVE IMPACT ON THE TANGIBLE AND INTANGIBLE ASSETS ENTERED INTO SERVICE

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**Abstract:** *Upon commissioning - tangible and intangible fixed assets are recorded in the inventory inventories, which includes the cost of transport and bringing the assets to normal operation in an operating environment (including installation, test, calibration, etc.). This process is strictly regulated, both normative and factual. After the asset is released, its amortization or accrual of depreciation charges begins. During the depreciation period, wastage is recorded, but no account is taken of innovation aging. This reporting has the side effects of rapid technical developments in communications and information technology. This article attempts to provide a methodological explanation for this manifestation and to find an approach for determining the magnitude of scattering or value-estimation of the dynamic asset environment.*

**Keywords:** INNOVATIVE AGING, SIDE EFFECTS IN THE EXPLOITATION OF MATERIAL ASSETS, INNOVATION DEVELOPMENT

## ***1. Innovative basis for the development of tangible and intangible assets***

Tangible fixed assets are developing both in technology and innovation. A problem arises when defining their fair value by traditional and convectional approaches. New approaches, methods and techniques are needed to derive fair values of machinery and equipment. The evaluation methods should satisfy and reflect the demand for flexible organizational forms regarding their development [1,4]. With new technologies - machines and devices follow an upward trend of constantly innovative solutions, the problem of their production exploitation is also developing in this direction. Intensive development of the production yields other dimensions that are closely related to more efficient use of the main tools such as machinery, equipment, etc.[2,5,6]. The current problem of development is not only the creation of high-tech equipment and the provision of production needs, but above all the creation of a production system of machines, equipment, etc., which will also solve the question of their best use [3]. This system also defines the so-called the effectiveness of the tangible and intangible assets in their operation or the ability of the industrial plant concerned to best use these assets. This means a constant study of the impact factors on their devaluation as a result of their rapidly aging innovation. Consequently, their depreciation will not be accounted for only when an asset valuation is carried out, but will require a dynamic environment to permanently regulate the production assets [7,8]. This interference will include the regulation of the side financial effects resulting from the constant innovation aging of tangible and intangible assets. The distinctive features of this modern development are that we are looking for ways to flexibly use the forms of innovation development induced by the impacts of innovation aging with to increase the possibilities for optimal use of production assets [5]. All this is achieved by combining traditional approaches with the latest achievements in communications, electronics and so on. Therefore, the problem of the development and exploitation of tangible and intangible assets is also a problem for the development of the industry as a whole. In the context of accelerating globalization and increased market competition, the market and consumption pose permanent issues to industrial firms, related to their competitive advantages, incl. strategies focused on quality, development, innovation, etc.[9]. These are responsible issues relating to the clear formulation of the objectives of profitability, innovative development, the introduction of quality standards, the preservation of the environment and energy efficiency. And this means taking into account all influences on assets and their relative weight in the final economic results.

On the other hand, improving management and marketing strategies, improving social services and paying greater attention to human resources is also one of the priorities of their future

development. This will also entail reorienting the activities of industrial firms from globally-priced low-value manufacturing industries to small niches based on specific competitive advantages and innovative products with higher added value. Long-term production flexibility is needed, in line with rapidly changing market conditions and a successful search for new market niches and partners in industrial activities and taking into account the innovation aging of technology and technology. This means that many factors will influence the promotion of this process of mastering innovation aging at the level of an industrial firm, including the fact that an increasing number of people will be part from this organizational and financial process. In this situation, the development of production capacities of these enterprises requires equipment with a higher degree of automation, high flexibility and greater production capabilities. These specific features are hardly taken into account in ongoing planning and financial reporting and also in the possibilities for its long-term development. Strategic management of industrial firms should be directed problems, product quality, and optimal use of machines and equipment.

Another part of the goals are the object and scope of the activity, the range of the production process, the structure of the placement, the expansion of the market with flexibility, the continuous marketing research, The choice of the approach to the development of production equipment and the constant consideration of innovation aging is of the utmost importance for the efficient operation of the whole production system of industrial firms. In the conventional approach of structuring the system of machines defining the production possibilities, it is usually used the method of proportionate distribution of the number of different types of machines.

The principle is to observe their technological purpose with the needs of capacity to implement production orders. Exploration of these impacts is critical to the normal course of the production process and better results from the business operations of industrial firms. Therefore, this report proposes a new approach to identifying the development of manufacturing capacities of industrial companies on an innovative basis, taking into account all side impacts that form the overall asset efficiency [10].

The definition and development of production machines in the context of rapid technical development means seeking a balanced balance between the available technological equipment and the additional needs. The latter means the supply of new machines, the modernization of some of them, the replacement of some with new ones due to their physical wear or complete innovation aging, introduction of new organizational methods, etc.

This also means that the innovation impact imposes new requirements and restrictive conditions on the whole structure of the production system, and production machines. The latter should be

considered not as a static parameter but as a constantly changing dynamically functioning system. Properly considering the impact of these innovation factors already creates conditions for the flexible operation of the whole system of machines. which also undergoes changes during the different stages of work. The other change is related to the impact of innovation development directly on the production equipment itself. Contemporary production is also characterized by the very early technological innovation of technology and technology. In order to address these issues, industrial firms should clearly formulate their goals of profit, corporate growth, social contributions, skills and working conditions, as well as environmental protection.

Their strategic management should address the issues, product quality, the scope and scope of the business, the range of the production process, the layout structure, expanding the market with flexibility, continuous marketing research and optimal use of production machinery and equipment.

Investigation of the state, development and innovative aging of the assets in the process of their exploitation  
Innovative aging and its financial effects can be explored in the following two areas:

**1. Investigation of the development of the active equipment with a relative change of the parameters compared to the new machines.** Broad possibilities are being developed to analyze the change of the technical and economic indicators by using analytical and imitation models based on statistical surveys and statistical information. There are conditions to predict the technical condition of the active equipment by forecasting the change of its parameters under the influence of their innovative aging.

**2. Formation of equipment development models for virtual system operation.** In this case, the construction of the analytical and imitation models is carried out according to the prognostic indicators of already established such systems.

In this case, the construction of the analytical and imitation models is performed on predicted indicators of already built such systems. To what extent these data are sufficient, if it proves to be insufficient, additional data from operating systems or their elements, which are as close as possible to the modeled technical system, are sought. To solve such tasks it is necessary to model the overall change in the technical condition of the equipment under the influence of innovation aging.

If we have to solve a problem that deals with the impacts of both directions, we, with regard to the first direction, model the existing equipment and in the second we model the technical state of an analogue equipment or a separate actual operating equipment.

**3. In order to determine the technical condition of the equipment, we can apply the principles of the law for the distribution of the aggregate error by processing the details of these machines using a known mathematical apparatus.**

This in essence also means determining the relative lagging of the parameters of the equipment in operation in relation to the new machines.

However, the results can significantly differ from their normal change over time.

In connection with this, the task of forecasting arises by using the total error distribution coefficient for the batch of details (group of machines).

Then the long-term trend of amending the law on the distribution of the summary error can be considered to characterize the change in the technical condition of the equipment.

In this case, faults in the equipment (worn parts, inaccuracies, etc.) are not recorded. Long-term forecasting with application of the law for the aggregation of the processing error of the details can be used in case of a specific set-up time for the development of the equipment because the short-term change of the law for the distribution of the summary error characterizes the way of setting the equipment, wear of tools, temperature deformations and other temporary causes. Short-term forecasting is rather necessary for operational quality management of equipment in the course of its operation, exploitation.

**4. Determination of the error distribution density as a basis for relative change of the parameters characterizing the asset condition under the conditions of the innovation impact**

The production process involves different types of machines, type and physical state.

Each of these process units defines different performance and different state of the parameters.

In each of these machines, innovative aging occurs at different times and in different stages of the manufacturing and technological process. The innovative innovation aging will be considered for each machine as a random process.

We look at two types of non-stationary, random or quasi-random processes  $X(t)$ . For the purposes of our study of random and quasi-random processes, we will only accept the term "random processes." The first type is by itself non-random random processes in the exact sense of the word, the distribution density  $p(x, t)$ , which slowly changes over time. Slow change in distribution density is understood as an opportunity to divide the length of a process that takes the property quasi-stationarity (in the exact sense of the word).

We consider a one-dimensional, random random  $X(t)$  represented by a separate realization  $x(t)$  in N-type with step  $h$ , i. x.  $(x_n)$ ,  $n = 0, 1, 2, \dots, N-1$ .

Conversion is assumed to be centered, ie.

$$\frac{1}{N} \sum_{n=0}^{N-1} x(nh) = 0 \tag{1}$$

The estimation of the distribution density for  $X(t)$  can be found by the formula:

$$p(x) = \frac{N_x}{NW} \tag{2}$$

where:

- the number that is centered on  $x(t)$ , represented by  $N$  with the meaning of the interval  $x \pm \frac{W}{2}$

An estimate of the distribution density for the middle of each  $i$ -th interval is expressed by

$$p_i = \frac{Nik}{N(b-a)}, i = 1, 2, \dots, k \tag{3}$$

where:  $k$  - an integer at equal intervals over which the entire variation range is broken  $x(t); [a, b]$  - the examined variation range  $x(t)$ . The estimation of the distribution density  $p(x)$  is displaced. Shuffled estimates

$$b[p(x)] = E[p(x)] - p(x) \tag{4}$$

are approximately:

$$b[p(x)] \approx \frac{W^2}{24} p(x) \tag{5}$$

where:

$p(x)$  - a second derivative for  $p(x) * x$ .

Evaluation dispersion

$$D[p(x)] \approx \frac{c^2 p(x)}{2BTW} \tag{6}$$

where:

$c$  - a constant quantity equal to a unit of limitation on the analogue - the frequency of noise. It is supposed to be random process  $X(t)$  has the highest frequency  $B$  (in hertz) and the realization  $x(t)$  is set in the final time interval  $T(c)$ .

A solution to the task of diagnosing or forecasting equipment status is the assessment of the distribution density in the type

$$p_i = \frac{Nik}{N(b-a)}, i = 1, 2, \dots, k \tag{7}$$

but it is inconvenient due to the large size  $k$  in the representation of  $p(x)$ . It is therefore advisable to proceed to a description of the model  $\pi_i$ ,  $i = 1, 2, \dots, k$  in the form of some analytical expression.

By predicting the time of the outfall random process or the parameters of the distribution density model, using the method of selecting the structure of predictive models, the future technical state of the equipment can be determined. This means determining how much productivity has decreased in relative terms of the old machines in the result of their innovative aging versus that of the new machines.

The conclusion is that it is not necessary to predict the incipient aging for each machine individually and in general for the entanglements involved in this process  $X(t)$ .

This cumulative result is more convenient for accounting for the total innovative aging in terms of dynamically changing conditions and the magnitude of the impact factors.

The second type of random processes under consideration refers to non-stationary random processes in the broad sense of the word, moments that slowly change over time.

It is believed that the process has less time-mathematical expectation and dispersion, but also a correlation function that depends on the starting point of the calculation.

Slow changes in statistical characteristics are understood as an option to divide into the process of sufficiently long stretches having the properties of quasi-stationarity or the stage is divided by the area of processes with predominant properties of quasi-stationarity.

#### **5. Assessing Influential Innovation Factors and Determining Dominant Parameters**

These parameters of the equipment, which have the largest relative share in the formation of the productive result, are dominant. In this case, we will only look at their change in operating conditions.

I accept that they are theoretically true.

The parameters of the equipment are physical quantities characterizing the performance of its components, the importance of which is their technical condition (performance, efficiency, etc.) and the requirements for repair or maintenance.

Typically, this is set by construction parameters of parts, assemblies and machine as a whole. These impacts are related to their physical extinction.

Thus, parameter variations can be considered as a function in a range from zero to extreme (extreme) variation.

The aggregate expression of the Impact Factor grouping function allows to examine the variation of the parameters at a given time as a sum of random variables. One of the most influential factors in operating conditions is the wear of the parts.

This leads to the modification of the performance parameters of the elements, - they characterize the average operating load.

The deviation of the parameters is actually the difference from the actual state or the theoretically given (constructively) to those of the new machines that generate the innovative aging. Wearing details has a great deal of impact on machine performance. It leads to a decrease in their productivity, deterioration in quality and frequent stays.

Consequently, the parameters that will change the productivity of the machine or the parameters that will lead to a decrease of productivity, increase of the marriage (quality) and increase of the stay of the machine will be considered as dominant parameters, thus decreasing and the effective time-to-work fund.

All these changes in the present case take them as a basis of comparison and do not take them into consideration, but take into account only the difference between the parametric capabilities of

the new machines stopped by the old ones. In the end, this will also reduce the financial performance of their work.

Or this is the negative impact of the innovative aging that has occurred in them.

### **Conclusion**

In the economic practice in the development of production, no account is taken of the changes that are made, and when planning and determining the volume of production that can be produced, only the initial data (indices) of the assets to ensure this production are taken.

Changes that may occur due to the impact of innovation factors that form innovative innovation are not taken into account. The latter may lead to relative changes in machine parameters and hence to a reduction in expected financial results. This decrease will depend on the level (difference) between the parameters of new and old machines.

With the proposed approach to taking into account and innovation aging, many of these side effects will be taken into account and controlled.

### **Literature**

1. Damianov D. Trends in Industrial Development and Automation of Discrete Production Processes, ADP, Revised and Edited Collective Volumes ISSN 3946 -2011.

2. Damyanov D. Innovations, PRIMAX Ruse, ISSN 978-954-9972-94-8

3. Koleva, N. & O. Andreev (2015). Approach to determine the level of service for the components of the final product. Collection of Scientific Papers - 13th International Scientific Conference "Management and Engineering" 15, Sozopol, ISSN 1310-3946.

4. Damianov D., Demirova S., Rachev D., Investigation of Factors Affecting the Operating Life and Productivity of Machines in Discrete Production, XXIII Conference "ADP", 2014, Sozopol, Bulgaria, ISSN 3946 -2014

5. Damianov D., Demirova S., Determining innovation activity of undertakings with discrete character of production, XX Conference "ADP", 2011, Sozopol, Bulgaria

6. Demirova S., Determination of the lifetime of engineering products based on innovative obsolescence, 8th INTERNATIONAL CONGRESS "MACHINES, TECHNOLOGIES, MATERIALS", Varna, Bulgaria, 2011

7. Demirova S., Innovative obsolescence and its impact on production development of industrial products, International scientific journal "Innovation", Year VI, ISSUE 1/2018, pp.7-9

8. Nikolov B., Building a Risk Management System - a Key Factor for Effective Risk Management in Enterprises, Scientific Journal of Industrial Management, year 8, issue 1., TU-Sofia, SF, pp. 70-77, ISSN1312-3793, (2011)

9. Nikolov B., Tcholakova V., Aspects of risk management in logistics activities of enterprises. application of fault tree analysis (fta), Innovations in discrete productions, Year III, 2/2015

10. Nikolov B., Process Management - a Key Factor for Enhancing the Competitiveness of Enterprises, 10th International Conference on Advanced Materials and Operations AMO'2010, 27-29 June, Varna, p. 65-69, ISSN1313-4264

11. Tomov P., "Innovative solutions for the automation of discrete production engineering" 12th International conference on "standardization, prototypes and quality: a means of balkan countries' collaboration", Kocaeli from 22nd to 24th of October 2015

# DEVELOPMENT OF A FORMAL MODEL FOR THE IMPLEMENTATION OF BUSINESS NETWORK REENGINEERING

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**Abstract:** The dynamics of the environment in which businesses operate underlines the need for new tools and approaches to management engineering. There has been recently a growing interest in finding comprehensive solutions covering all aspects of the entire business management. Besides, with a more pronounced customer-centred focus of the company, the competition now takes on a brand-new character considering the fact that the rivalry is not between individual companies, but between entire chains of manufacturers and suppliers. The research study focuses on the need for innovative engineering solutions in response to company's management processes. A network approach has been proposed as an opportunity to implement the reengineering of external processes (X-engineering). Moreover, such a proposition is strongly substantiated by the fact that modern companies are prone to expand their activities in the (cyber) space, working together in different types of business networks (Businessnetwork-BN).

**Keywords:** reengineering, X-engineering, network approach, business network, model

## I. INTRODUCTION

Overcoming conventional thinking about business management requires the organization to respond quickly to market trends and to focus exclusively on the "processes, performance outcomes and customers". Otherwise, few of the companies in favour of the traditional business approach might be able to survive in the present-day dynamic business environment. Process integration is becoming absolutely critical for businesses, as is the need for newfound methods to help organisations become more efficient and competitive. Today's networked economy brings a new and extended scope of business activity. The use of new technologies for trading platforms and cooperation enforces the introduction of innovative ways of achieving the desired effect.

The present paper explores the need for new solutions in the engineering of business process management. According to Hammer and Stanton [1], the organisation and management of business processes is an activity that relates to the immediate challenges facing businesses at present. They should, therefore, identify the key processes and eliminate those that do not add value. As perceived by Hammer and Stanton, "the main aspects of reengineering ally with the possibility of eliminating inefficient processes in the organisation, from order processing and supply up to the provision of service to customers". More notably, businesses "should take on and fight off the challenges from the market trends, changes, the introduction of new technologies and the emergence of strong competitors". The authors argue that the process-based approach is an essential, though not the one and only, prerequisite for sustainable development. All that matters today is the dynamics-driven approach and the call for vigorous pursuit of business processes reengineering.

Currently, there is a new wave of interest in the concept of business process reengineering. A characteristic feature of the «traditional» reengineering is that it focuses exclusively on the internal processes of the company and is carried out within the organizational boundaries of the enterprise. Despite the fact that some companies have seized the opportunity to achieve a substantial reduction in their expenses, increase in their business profits and turnover, improved quality and productivity, and yet, the close juxtaposition between the huge amount of energy, money and effort being invested in the projects on traditional business-process reengineering, undoubtedly reveals that such an approach fails short of the company's management expectations. Thus, despite the earnest endeavours of the forefathers of this direction «to give it a second chance at life», general agreement should be reached with some researchers and unwillingly, though, to acknowledge openly that the business-process reengineering has already been exhausted and the gaze should alternatively rest on external processes reengineering. This unconventional and a more "refined" type of business process reengineering is known in the

scientific literature as "X-Engineering". It is assumed that "X" stands for the place where organizational boundaries may be crossed [2].

The research paper is based on the main hypothesis that reengineering is not bound to be confined within the walls around a given office or enterprise, but stretch forth to relate to processes occurring between the company and its customers, suppliers and partners.

## II. OPPORTUNITIES FOR THE IMPLEMENTATION OF EXTERNAL PROCESSES X-ENGINEERING

The network approach has been proposed as an opportunity to implement the reengineering of external processes (X-engineering) in view of the fact that modern companies are inclined to perform their activities in the (cyber) space, pooled together in diverse types of business networks (Businessnetwork-BN).

Networking is a phenomenon that has recently crossed the threshold of specific business terminology despite its 21st century credentials the very creation of business networks is not in itself a novelty. Both academics and practitioners have pointed out the benefits which the execution of BN-based activities can provide as a new way of improving business performance with just a handful of them having directed their attention to productivity and usefulness of networking. For example, Gummesson (2008) [4] suggests that just as society is built on a complex network of relationships, so is a company's capability for gaining its competitive advantage through effective networking.

The network concept, in general, explores the synergy of strengths, dependencies, responsibilities, changes, money, information and benefits that accrue from network connections and relations [5]. In light of this, developed should be new approaches to the development of intercompany relations and enhanced effectiveness of the user interfaces between several independent participants in BN. Accordingly, as a direct effect of the new realities, there is also the need to implement the BN principles of interorganisational coordination and collaboration.

The network approach identifies two issues of critical importance for achieving business objectives: 1) how to mobilise miscellaneous company contractors and subsequently 2) how to develop the mechanisms supporting joint behavior and social coordination with the intention of expedient problem solving [6]. The above two issues, however, relate to the traditional strategic management and are associated with the development of a conceptual framework that takes into account such BN relationships as the interactions between customers, suppliers and other third parties, with the identification of possible interrelations and with the establishment of priorities while managing critical relations.



The principal participant in BN is the organization that develops the respective analyses of customer orders, service requirements and the resultant activities, necessary for the proper execution of orders. BN is a structure of interorganisational relations between participants, interconnected and working together in collaborative cooperation to ensure accurate servicing of customer orders [7].

Widely applicable, and of common interest as well, are three types of BN:

- *Common network.* In a common network, there is one central organisation that maintains stable relations with a specified limited number of external suppliers and distributors, concurrently with the provision of services to organizations outside the network. The corresponding business partners should be carefully selected and tightly constrained to contractual obligations.

- *Internal network.* The internal network consists of organisational parts within the organization itself that are engaged with the processes of buying and selling goods and services among themselves at prices determined by the open market. To ensure the costs and quality of the products, as part of the transactions, these particular organisational parts have the right to buy and sell outside the network.

- *Dynamic network.* The dynamic network contains a large number of companies or their divisions, each serving a chain of their own from their own perspective, making adequate provisions for supplying customers, adding and removing temporary groups.

The model of an effective business network comprises in itself one or more business organisations whose relationships with the others (in the absence of a management centre) support the basis (the very backbone) of the system in a way that enables the small distinct competitive advantages of every single partner, through mutual complementarity, to help generate a new competitiveness of the network as a whole.

### III. FORMAL MODEL FOR THE IMPLEMENTATION OF BN REENGINEERING

A complex business market can be perceived as a network with the points of linkage (nodes) being the business units - manufacturing and service companies, while the possible connections between them reveal the actual relationships, flows or transactions. Both the relations and the nodes, in terms of business, have their own specific content. The two components are "heavily burdened" with resources, knowledge and understanding in all the diversity of forms and structures. The heftiness hereto results from the complex interactions, adaptations and investments in and between companies over time. All the existing theories about network relationships are frequently built upon the capacity to perceive similarity traits such as trust, commitment and mutual understanding. Although these studies provide direct insight into the social aspects of relationships, they often involve simple purely exploratory network tasks with low economic benefit. Stronger network connections capitalizing on the interactive nature of networking where the participants are involved in joint activities towards the achievement of economic goals and gaining financial benefits turn out to be readily identifiable and carefully examined by today's research in the field of business networks and relationships [8].

Introduced in the paper is a formal model for improvement (reengineering) in BN, passing through three stages:

**First stage: Analysis of the momentary status**

The options for improving BN, are primarily, first and foremost, contingent upon the creation of a network map to enable the description of its momentary status. All the network nodes and relation should be clearly marked on BN map. The nodes stand for the business units – manufacturing and service companies, while the links between them show relationships, flows or transactions. The network map is a sophisticated tool providing visual trace route of all the company's links and allowing for further strategies to be developed as to the creation of brand new links.

**Second stage: Implementation of BN reengineering.**

This phase covers the following two sub-phases:

- Planning and implementing the respective reengineering-related changes as efficiently and effectively as possible;
- Analysing the overall reengineering performance in the enterprise.

The steps identified require the adoption of two repetitive procedures:

1) The first procedure relates to the study of the type of the BN the company is engaged in and assessment of its development. Investigation into the type of BN requires a specific approach to its analysis. The different levels of analysis have a distinct effect upon the multitude of subgroups in the network community. As determined by Tortorello and Krackhard (2010), proposed are four levels of analysis from 0 to 3.

- Level 0 describes the structure of the network as a whole;
- Level 1 specifies the properties, the characteristic features of the network participants;
- Level 2 refers to the relationships between all pairs of participants;
- Level 3 denotes the perceptions that each of these participants has in binary relationships.

2) The second procedure necessitates network connectedness to other BN, following the prescribed model of network construction. As reported by Krebs (2006) [6] there are four phases in the construction of an effective model, each characterised by its own topology.

Each subsequent phase creates a more adaptive and flexible network structure with respect to the previous one. Network mapping gives a close view of the progress and plots the newly-established network weavers.

The first phase of network development is of "Scattered Fragments" type. In it, most communities are formed as a small cluster, organised on the basis of a relatively small number of common interests or objectives. These clusters are normally isolated from one another and represent small groups of 1 to 5 organisations. (Figure 1).

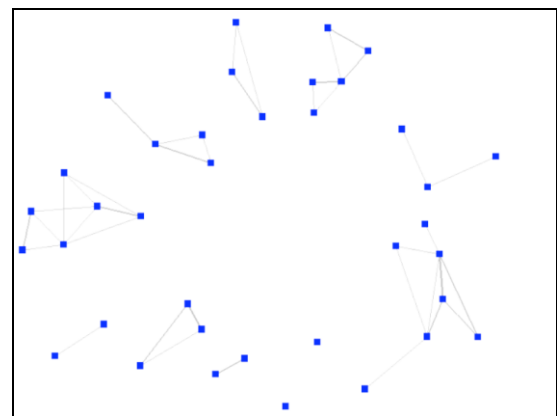
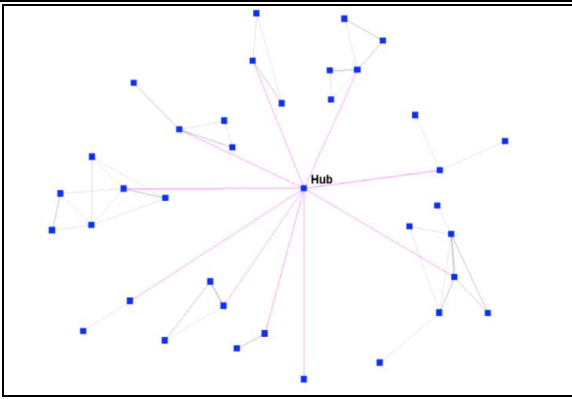


Fig.1 The first phase of the "Scattered Fragments" type

If these fragments are not further organised, the community structure remains weak. Without the commitment of active leaders to take responsibility for the network construction, the spontaneous relations between groups will disappear or appear very slowly.

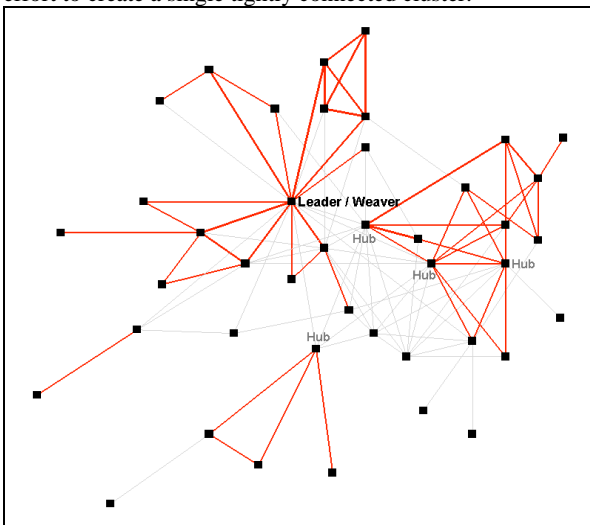
The second phase of the process is of "Hub- and – Spoke" type (fig. 2). Here emerges the leader or the so-called "weaver" of the network to twist together the scattered fragments. The Centre should have a breadth of vision, energy and aptitude for getting in touch with multiple groups and for ensuring the smooth flow of information between them. This is a phase of critical importance for starting the community, i.e. everything depends on the leader, who is also the hub of the network.



**Fig.2.** The second phase of “Hub -and-Spoke” type

The "hub-and-spoke" model, however, is only a temporary step in the steady growth of the network. This phase should not last for too long, i.e. power and influence are concentrated in one node (Hub). If the leader leaves or fails to stay in power, then, observed is a return to the fragmented community. In sound or well-established networks the “threads” of the centre do not stay away from one another for very long. The centre connects these clusters that work together in close collaboration or encourage others to start “knitting” the network. Notwithstanding the fact that this is also a temporary structure, the "hub-and-spoke" model is principally the most advantageous topology in most immature communities.

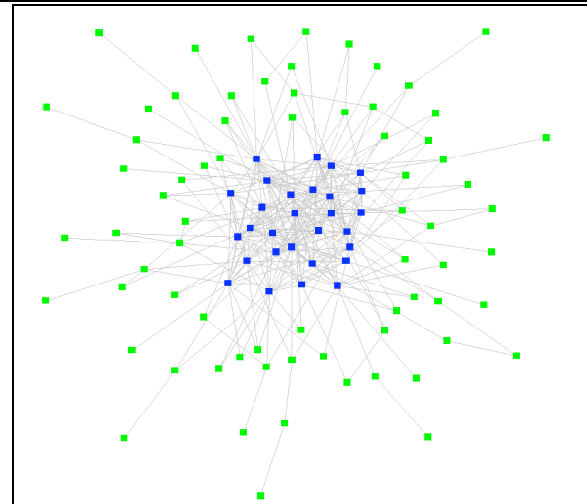
The third phase is a network of the **Multi-Hub** type (fig.3) with several centres. Presented in the figure are four clusters (marked with thick red links) that have created very weak relations (grey links) with one another. The weak relations are subject to research in order to establish whether they can be strengthened in an effort to create a single tightly connected cluster.



**Fig. 3** The third phase of “Multi-Hub” type

The leader connects different individuals, organisations and clusters. This is the phase that unfolds a new dynamics - the power of “weak relations”. Weak relations are those that are not as frequent and intense as the strong network relations that form the very backbone of the network.

The final phase is of the **Core/Periphery** type (fig.4). This is the model of sustainable BN that occurs after a prolonged period of building a network designed to meet the requirements of several centres. The network of “Core/Periphery” type is a stable structure that can be connected to other well developed BN.



**Fig. 4** The fourth phase of “Core/Periphery” type

The network core in this model contains encloses they key members of the community, including a large number of those who are network weavers and have developed strong relationships among themselves. The periphery takes in three groups of nodes commonly linked to the core through looser relationships:

- 1) ) Those which are new to the community and work to get to the core;
- 2) Bridges to different communities in other places;
- 3) Unique resources that work outside the community and can span over scores of communities.

**Third stage: Development of an effective BN model:**

As observed by Krebs and Holley (2006), the construction of effective BN demands the following:

- The participants (the nodes) connect to one another in pursuit of common goals;
- Maintaining diversity in the network is of vital importance. Although network participants form clusters with common goals, to keep the network viable, they should also uphold diverse relations to other nodes and clusters, which, in turn, leads to maximization of innovations in the network;
- Initiating sustainable network that constructs numerous paths between each two nodes. In cases of violation or removal of a single or multiple nodes or relations, there should be other ways of continuous flow of information between the remaining nodes;
- Some nodes can be readily distinguished and are more prominent against the others. This gives sufficient grounds for parting of the ways and their designation into separate centres, brokers or network boundaries;
- Most nodes in the network are connected through indirect relations. For example, the A-B-C-D network shows a direct relation between A and B and indirect relationship between A and C and A and D. The average length of the trajectory across the entire network should be relatively small. The presence of long paths in the network is likely to cause delay and distortion of the flow of information.

**IV. CONCLUSION**

The scope for implementation opportunities of “X engineering” creates the necessary prerequisites for the development of integrated long-term relationships between the separate enterprises in a given business network, a high degree of openness to the accession of new partners, which, consecutively, allows the participants to adapt easily and accordingly to the high-speed changes in the external market environment.

All in all, the reengineering project of external processes should give priority to the construction of effective BN, which will enable the participants to:

- make more efficient use of their production capabilities (minimum stocks, reduced production cycle time, etc.) and realize regular income and strong relations;
- release financial resources that can be infused into other strategic activities;
- gain strategic competitive advantages derived from the existence and growth of the network, ensuring the provision of activities, unlocking economic potential, acquiring teamwork skills and joint collaboration habits, enhancing the technological and technical levels of production, et al.

**BIBLIOGRAPHY:**

[1]. Hammer, M., Stanton, S. (1995) *The Reengineering Revolution: A Handbook*. Harper Collins Publishing;

[2]. Champy, A. (2002) *X-engineering the Corporation: Reinventing your Business in the Digital Age*, Warner Books, New York, NY;

[3]. Todorov, K. (2000.). *Basics of the small business*. Sofia, Trakia-M, p. 280;

[4]. Gummesson, E., (2008) "Customer centricity: reality or a wild goose chase?", *European Business Review*, Vol. 20 Issue: 4, pp. 315-330, <https://doi.org/10.1108/09555340810886594>;

[5]. Ahmed, P., Hardaker,, Carpenter, M. Integrated flexibility – key to competition in a turbulent environment. *Long Range Planning*, Vol. 29, №4, 1996, p. 563;

[6]Krebs, V., J. Holley, *Building Smart Communities through Network Weaving* © 2002-2006 ;

[7]. Panayotova, T.(2010) Engineering of business process management in a dynamic environment, First international scientific and practical conference “Economics and management”, “Business and public sector in economic crisis - problems and perspectives”, SSN 1314-197X, TU Varna, 2010, p.p. 261-266;

[8]. Medlin, Christopher John, *Interaction in business relationships: A time perspective - Industrial marketing management*, 2004;

[9].Tortorello, M., D. Krackhard, *Activating Cross-Boundary Knowledge: The Role Of Simmelian Ties Im The Generation Of Innovations*, *Academy of Management Journal*, 2010,Vol 53, №.1, 167-181.

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# LOW COST DEVICES FOR HOME AUTOMATION SYSTEMS

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**Abstract:** *The article presents the design of Home Automation System (HAS) with low cost and wireless system. This system is intended to help and supply support so as to meet the requirements of older and disabled in home. Also, the good home conception within the system improves the quality living reception. The switch mode and voice mode square measure accustomed management the house appliances. The video feedback is received within the automaton application that streams the video of IP Camera. The main control system implements wireless technology to provide remote access from smart phone. The design remains the prevailing electrical switches and provides additional safety management on the switches with low voltage activating methodology. The switches standing is synchronized altogether the system whereby each computer program indicates the real time existing switches standing. The system meant to regulate electrical appliances and devices in house with comparatively low price style, user-friendly interface and ease of installation.*

**Keywords:** HOME AUTOMATION, AUTOMATION PROTOCOLS, LOW COST CONTROLLERS

## 1. Introduction

Home automation is outlined as single or networked devices and systems that raise the protection and snugness of homes, maintain pleasant indoor conditions energy efficiently, facilitate inhabitant's residency and coping of everyday chores and enable.

Today we have a tendency to reside in twenty first century wherever automation is taking part in necessary role in human life. Home automation permits North American nation to regulate house appliances like lightweight, door, fan, AC etc. Home automation not solely refers to cut back human efforts however conjointly energy potency and time saving. The main objective of home automation and security is to assist incapacitated and previous aged folks which is able to alter them to regulate home appliances and alert them in crucial things. Home automation has created it potential to own what's typically noted as a 'smart home', a home that can detect and identify you, automatically adjust the lighting to your predefined style, open doors mechanically, play your favorite music, water your flowers within the morning, activate the safety lights in the dead of night and switch them off within the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in and around your house. It makes it potential to link lighting, recreation, security, telecommunications, heating, and air conditioning into one centrally controlled system. This allows you to form your house a vigorous partner in managing your busy life.

Automation or automatic management, is that the use of varied management systems for in operation instrumentation like machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, craft and alternative applications and vehicles with stripped or reduced human intervention. Some processes have been completely automated. Automation has been achieved by numerous suggests that as well as mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, like trendy factories, airplanes and ships typically use all these combined techniques. The biggest good thing about automation is that it saves labor; but, it is also used to save energy and materials and to improve quality, accuracy and precision.

## 2. Low cost home automation controllers

There is a lot different approaches to the home automation offered on the market. Insteon may be a home automation (domotics) technology that permits lightweight switches, lights, thermostats, leak sensors, remote controls, motion sensors, and other electrically powered devices to interoperate through power lines, radio frequency (RF) communications, or both. It employs a dual-mesh networking topology during which all devices square measure peers and every device severally transmits, receives, and repeats messages. Like alternative home automation systems, it's been related to the net of Things. Android@Home was announced by

Google in May 2011. The system is declared to figure with a mesh network within the 900MHz frequency bands. Google chose 900MHz because it is least likely to be crowded than the wi\_2400 spectrum. It is assumed that their protocol, announced in the Google's I/O Developers Conference, was based on SNAP from Synapse Wireless. It is still a closed protocol.[2] The Z-wave is a wireless communications proprietary standard designed for home automation, specifically to remote control applications in residential and light commercial environments. This technology, which is developed by Sigma designs' Zensys, uses a low power RF radio embedded or retrofitted into home electronics devices and systems, such as lighting, home access control, entertainment systems and household appliances. The technology has been standardized by the ZWave Alliance, an international consortium of manufacturers that oversees interoperability between Z-Wave products and enabled devices [4].

ZigBee may be a specification for a collection of high level communication protocols victimization tiny, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio.

The technology outlined by the ZigBee specification is meant to be easier and fewer dear than alternative WPANs like Bluetooth. ZigBee is targeted at radio frequency (RF) applications that require a low data rate, long battery life, and secure networking [5]

The next statement put forwards the design of home automation system using KNX. The design is based on a standalone embedded system board KNX at home. Home appliances are connected to the KNX module and communication is established between the KNX and Android/iOS mobile device or tablet. The home appliances are connected to the input/output ports of the embedded system board and their status is passed to the KNX module. The device with high cost and scalable to less modification to the core is much important. It presents the design and implementation of automation system that can monitor and control home appliances via android phone, ios phone or tablet. KNX could be a standardized (EN 50090,ISO/IEC 14543), OSI-based network communications protocol for intelligent buildings. KNX is that the successor to, and convergence of, three previous standards: the European Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB). The KNX standard is administered by the Konnex Association [3].

This commonplace is predicated on the communication stack of EIB however enlarged with the physical layers, configuration modes and application expertise of BatiBUS and EHS.

KNX defines several physical communication media:

- Twisted pair wiring
- Powerline networking
- Radio
- Infrared
- Ethernet (also known as EIBnet/IP or KNXnet/IP)

KNX is intended to be freelance of any specific hardware platform.

A KNX Device Network are often controlled by something from associate 8-bit microcontroller to a computer, according to the needs of a particular implementation. The most common style of installation is over twisted try medium. KNX is approved as associate open commonplace to International commonplace (ISO/IEC 14543-3) European commonplace (CENELEC nut 50090 and CEN nut 13321-1) and China Guo Biao(GB/Z 20965).

KNX has quite one hundred members/manufacturers together with terrorist organization, Bosch, Miele & Cie kilogram, ON Semiconductor, Schneider Electric Industries S.A., Siemens, Uponor Corporation and Jung.

There are three categories of KNX device:

1. A-mode or "Automatic mode" devices automatically configure themselves, and square measure meant to be oversubscribed to and put in by the tip user.
2. E-mode or "Easy mode" devices need military training to put in. Their behavior is pre-programmed, however has configuration parameters that require to be tailored to the user's requirements.
3. S-mode or "System mode" devices square measure employed in the creation of customized building automation systems. S-mode devices have no default behavior, and should be programmed and put in by specialist technicians.

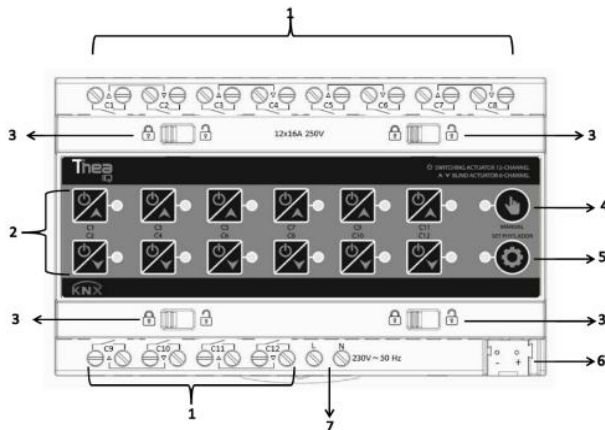


Figure 1: Logo of the KNX and example of controller

KNX, associate abbreviation of Konnex, is associate open commonplace (see nut 50090, ISO/IEC 14543) for business and domestic building automation.

KNX devices can manage lighting, blinds and shutters, HVAC, security systems, energy: KNX Applications management, audio video, white goods, displays, remote control, etc.

KNX evolved from 3 earlier standards; the ecu Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB or Instabus). It will use twisted try, power line, RF, infrared or Ethernet links in a tree, line or star topology. On this network, the devices form distributed applications and tight interaction is possible. This is implemented via interworking models with standardized data point types and objects, modelling logical device channels. The KNX commonplace has been designed on the OSI-based EIB communication stack extended with the physical layers, configuration modes and application experience of BatiBUS and EHS.

KNX installations can use several physical communication media:

- Twisted pair wiring (inherited from the BatiBUS and EIB Instabus standards)
- Power-line networking (inherited from EIB and EHS - similar to that used by X10)
- Radio (KNX-RF) based on Z-Wave protocols
- Infrared
- Ethernet (also referred to as EIBnet/IP or KNXnet/IP)

KNX is not based on a specific hardware platform and a network can be controlled by anything from an 8-bit microcontroller to a PC, according to the demands of a particular building. The most common form of installation is over twisted pair medium.

KNX is associate approved commonplace by the subsequent organizations, (inter alia)

- International standard (ISO/IEC 14543-3)
- European standard (CENELEC EN 50090 and CEN EN 13321-1)
- US standard (ANSI/ASHRAE 135)
- China Guobiao (GB/T 20965)

It is administered by the KNX Association, a non-profit organisation governed by Belgian law which was formed in 1999. The KNX Association had forty four registered hardware and code merchandiser members from 44 nations as at one July 2018. It had partnership agreements with lot of installer companies in 163 countries and more than 440 registered training centres. This is a royalty-free open standard and thus access to the KNX specifications is unrestricted.

KNX encompasses tools for project engineering tasks such as linking a series of individual devices into a functioning installation and integrating different media and configuration modes. This is embodied in a Engineering Tool Software (ETS) suite.

### 3. Conclusion

The main function of Home Automation with aim of monitoring, controlling home appliances. The primary focus is to make safe and secure the home we live in and have information on status of electronic devices.

As prime target, some household appliances were monitored and then used the information for controlling devices. Use of software's like ETS were integral part in completing the desired monitoring and controlling tasks.

There is enough devices on affordable price which give a good opportunity to create the fully functional home automation system with convenient remote control by IP or Bluetooth.

### 4. References:

1. <https://www.pcmag.com/article2/0,2817,2410889,00.asp>
2. <https://play.google.com/store/apps/details.com.google.android.apps.chrome.cast.app>
3. <https://www.pocket-lint.com › Smart Home › Smart Home news>
4. Z-Wave | Safer, Smarter Homes Start with Z-Wave <https://www.z-wave.com/>
5. [www.knx.org](http://www.knx.org)

# OPEN DATA FOR CITIES - MODERN ASSET TO DATA-DRIVEN ECONOMY

## ОТКРЫТЫЕ ДАННЫЕ ДЛЯ ГОРОДОВ - СОВРЕМЕННЫЙ АКТИВ ДЛЯ ЭКОНОМИКИ, УПРАВЛЯЕМОЙ ДАННЫМИ

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**Abstract:** This article aims to share results and practices of the research group at VFU in partnership with ICT Cluster-Varna for developing open data solutions for the city of Varna. The final goal is the establishment of open data platform for the city of Varna, Bulgaria. The results from the project Open Data for Smart Cities where API for specific open data for cultural heritage was developed under the funding from Varna - European Youth Capital 2017 and was also presented. Some new business models concerning data is summarized as the bases for new innovative software solutions.

**Keywords:** OPEN DATA, OPEN API, LOD, BUSINESS MODELS, PLATFORMS, SMART CITY

### 1. Introduction

Open Data is data that can be accessed, used and shared by everyone [1]. It became usable when it is not only publicly available, but also when it is distributed in machine-readable formats. This allows them to be created, shared and reused without limitations by different analysts and researchers, following the highest goal of extracting new knowledge. The Data-Driven Economy creates a need for data management infrastructure in each country [2]. The ability of data to be accessible and adequately used by anyone requires a culture of data use and in particular open data, which is the component of the digital "information and data handling" (an integral part of the modern model of digital competence). The European Union's strategies and policies for building a single digital market reflect in different aspects: access, the environment and the development of the economy and society. The idea of open data, although it occurs more than 10 years earlier than the open source concept, finds its application in society and business much slower [3, 4]. Open data is saved in well-known file formats. Very popular are practices with suggesting appropriate API in order to get easy not only for regular users but also for specific users like developers. Know the idea of API, REST API enhances to the usage of API gateways (as Amazon services). There are a lot of initiatives as OpenAPI Initiative (OAI) that was created by a consortium of forward-looking industry experts who recognize the immense value of standardizing on how REST APIs are described (<https://www.openapis.org>).

### 2. Open data platforms

An example of the usefulness of open data is visualized in the European Open Data Portal [5]. It depicts the economic, social and optimization benefits of open data and explains the benefits of opening data for increasing performance; developing the economy, for social benefits.

The importance of the topic of Open Data forces building of new platforms (new services) to monitor the level of usage. Some of them are:

Watch <a href="http://odin.opendatawatch.com">http://odin.opendatawatch.com</a>	appropriate disaggregations over time and for geographic subdivisions <ul style="list-style-type: none"> <li>openness - data is downloadable in machine-readable formats, accompanied by metadata and download options exist such as bulk download and user-selection or APIs, and have an open terms of use.</li> </ul>	Institute	of 180 countries cover age-62 openness - 83
Open Data Barometer <a href="https://opendatabarometer.org">https://opendatabarometer.org</a>	<ul style="list-style-type: none"> <li>existing of data</li> <li>data available online from government</li> <li>machine-readable and reusable formats</li> <li>dataset available free of charge</li> <li>data openly licensed</li> <li>dataset up to date, kept regularly updated</li> <li>easy to find information about dataset</li> <li>data identifiers provided for key elements in the dataset</li> </ul>	National Statistical Institute Company Register	rank 40 of 114 countries
European data portal <a href="https://www.europeandataportal.eu/">https://www.europeandataportal.eu/</a>	<ul style="list-style-type: none"> <li>readiness: Presence Policy, National Coordination. Licensing Norms, Use of Data</li> <li>portal maturity: Usability, Reusability of data, Spread of data across domains</li> </ul>	Open Data Portal Bulgaria	rank 15 of 32

Table 1. Open Data Monitoring Platforms

Name /URL	Types of Criterias	Data is Taken from	Bulgaria Rank
Open Data	<ul style="list-style-type: none"> <li>coverage -availability of key indicators and</li> </ul>	National Statistical	rank 8

In all of these platforms (even though on the platform of National Statistical Institute in Bulgaria [www.nsi.bg](http://www.nsi.bg)) there isn't any possibility to monitor regional country aspects. Moreover in some of the platforms (NSI too) an additional paid service is provided to buy data that is for particular business or city or region.

The findings from the fourth edition of the Open Data Barometer [6] show that while some governments are advancing towards these aims, open data remains the exception, not the rule. Everyone

should be able to access and use open data on an open web to allow them to participate fully in civic life. Without good data, it is impossible to hold governments to account for the decisions that they make, the policies they pass, and the money they budget and spend. In its fourth edition, the Open Data Barometer covers 115 countries and jurisdictions, a 25 percent increase on coverage from the last edition. The leaders for each region in our study are Canada, Israel, Kenya, Korea, Mexico, and the UK [7].

In Estonian open data platform [8] the following goals of opening up data are mentioned: to stimulate economy; to increase transparency; to provide access to information; to decrease the number of information requests and, consequently, also reduce the workload of public sector workers; to facilitate creation and management of open services for private and community sectors; to encourage migration to future technologies such as Linked Data, Big Data and Internet of Things.

Regarding the software, the practice of different cities around the world with open data platforms shows grouping of conversions around the use of several popular software platforms such as CKAN (Bruxell), Socrates (New York), Junar (Palo Alto ).

For the purpose of the analysis, a total of 32 cities in Europe with open data portals have been selected. Some of the typical categories for open data in the platforms are: population, economy, culture and leisure, transport, environment, security, tourism, and education.

A comparison of the number of open databases in the United States and Europe has been made in some key areas. (Table 2).

**Table 2 - Number of open databases in Europe and USA**

CATEGORY	EUROPE	USA
Population	75%	73.7%
Economy	67.9%	89.5%
Culture & Leisure	67.9%	63.1%
Transport	85.7%	84.2%
Environment	71.4%	73.7%
<b>Security</b>	<b>28.6%</b>	<b>84.2%</b>
<b>Tourism</b>	<b>46.4%</b>	<b>10.5%</b>
<b>Education</b>	<b>67.9%</b>	<b>47.3%</b>

The categories in which there is a significant difference in the number of open data are: Security, Education and Tourism. In the USA security is one of the categories with the highest number of open data, overtaken only by open data related to different economic parameters. For comparison, the "Security" category in Europe has the lowest number of open data compared to other categories. One of the reasons for the drastic difference is the adopted security policies and measures in the United States and the countries of Europe. The next category with significant differences is Education. There is much more open data on Europe on the state of the education system than in the US. Thirdly, with the most dramatic difference in the number of open data is the category Tourism. Nearly half of the cities analyzed create open data to help the tourism sector, while the US rate for the same category is only 10.5%.

The main focus in analyzing open data portals is to provide access to open data through the Application programming interface (API). A total of 24 open data portals provide access through the API to

the data sets. The fact that less than half of cities provide this opportunity is indicative of the degree of recognition of the need to use open data for both public and private organizations. Ensuring access through the API to the data would stimulate their active and more functional use. Portals that provide access through the API feature significantly more and diverse data.

### 3. Varna city open data practices

During last years a lot of projects concerning open data, big data or linked data are developed. With the "Open Data for Smart City" project, the partners - ICT Cluster Varna and Varna Free University formed the community, committed to the creation of regional data for public use, Varna Open Data portal as part of Smart City Varna. As part of the project in the first time, the data on the cultural immovable heritage in the city was developed, the open data structure was developed and the API for open data access and implementation of this API was demonstrated in the implementation of the interactive architectural heritage map (<http://31.13.250.54/>).

According to the fundamental principles of Open Data, it should be easily found, usable and accessible. In order to meet those criteria we have to develop an API which will be compatible with modern technologies and devices. This means that the data has to be presented in the most convenient format, which we decided will be a RESTful API. All the data can be searched by name, id, code or by distance. It also provides a method for submitting data updates that can be later approved and applied.

The desire of our team (Open data for Smart Cities) is to put the project results as the bases of new regional policy development for developing strategy, action plan for open data for Varna area. The initiative is leading from the ICT Cluster - Varna that is NGO from 30 IT companies in the region and VFU. In order for the analysis to be fully adequate to the needs of open data for Varna, the research has also set out whether and how open data are available in other cities in key areas for Varna, such as tourism, recreation and culture and education.

Personalizing data specific to the region is important for accelerating the development of the region's economy. For the Varna region these are data on tourism, ship design, education and other key areas.

According to the research team, successful open-city data platforms require combining data from different sources, using mashup technologies as example [9]. Data sources, both local (local authorities, different businesses, NGOs, scientific institutions, etc.) and automatically retrieved data from existing national and international platforms. For example, the opening of data and the provision of automated access to them by the European Space Agency (Sentinel project) would fill the gaps of air pollution on national and regional level. So, the best strategy for open data platform for city level is to use consolidated synergy-based practices.

A written suggestion to the mayor of Varna is deposited in March 2018 with survey of open data practices on city level and some suggestions for the first activities for the starting of the process. In this plan the important topic is not only the technical question of platform launching but the efforts to establish an open data policy for the city that comes from our team as a team of experts but also as citizens living and working in this city.

### 4. Open data and business models

Aggregating open data is more important if more people can use open data sets for developing applications. Starting new businesses

is an important activity where open data can be used. New type of data and data access technologies gives the opportunity to develop new types of business model. The main approach is the data-driven approach or data-driven economy.

A typology of big data business models is suggested by Schroeder [10] where types of data users, data suppliers and data facilitators are discovered and some dependencies are summarized. In the same time according to Deloitte there are six main business models concerning data: data-enabled differentiation, data brokering and data-based delivery networks. Harbor Research mentioned in the same article shows that some of opportunities are solo based (product Innovators and systems Innovators) and others are collaborative (data providers, data brokers, value chain Integrators and delivery network collaborators). Some researches (Brownlow, etc.[2]) from Cambridge Service Alliance investigates Data and Analytics in Data-driven business models for the innovation purposes. In their article the research is done by randomly selected companies in the areas (finance, insurance, publishing, retail, telecoms) and samples of 100 business start-ups were taken from the start-up incubator AngelList.

The key activities concerning data are: visualisation, distribution, data generation, data acquisition, prescriptive analytics, predictive analytics, descriptive analytics, and aggregation.

Some of the members of our R&D team participating in Varna StartUp weekend jury regularly for 4 years can share observations of some tendencies that is that participants propose to use mainly data generated from their own applications. They usually do not design data for analysis and future development of their application/solution. According to the data collecting and analysed from ICT Cluster - Varna already established Businesses in the region are using analytics for web apps successful development, mobile apps development, games development and IoT solutions. This is one of the focuses of digital transformation nowadays and only innovative teams from companies and innovative businesses or businesses involving emerging technologies are using analytics.

Guiding line for successful practice on the open data influence on city level are in Britain. There are a lot of cities in UK that are doing this and have their own policy to do this regularly. There are special tools that follow the quantity of opening data sets, new businesses, and open data companies that could be observed in details [11].

## 5. Summary

Open data technologies, practices, and policies require building a community of data-engaged citizens. This requires prioritization of this thematic area and its development by the various stakeholders in the following aspects:

- *Educational*: education of the citizens of Varna in depth, consistent with their experience, education and position.
- *Scientific*: The presence of 6 universities in the region, with a staff of 9 departments in the area of computer science and technologies, a research institute and a university hospital, form a basis for sustainable research practices and expanding the processing and analyzing available data to improve the quality of life with an emphasis on citizens living in the region.
- *Business*: for people doing business in and with Varna. Open data technology is a modern form of corporate social responsibility.
- *Policies*: Creating a priority for using open data for and from the region.

Open Data Practices are not only part of the Open Data Governance but they could be new models for corporate (social) responsibility. That means that not only public institutions but also companies and individuals can support the process of aggregating data, choosing appropriate data in order to be open. Open data have long been used in science and education [12, 13], but can increasingly be used in business - in knowledge management systems [14, 15] and multi-agent systems [16] that use data from the Internet environment.

## 6. Acknowledgement

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## References:

- [1] Momcheva-Gardeva G, A. Ivanova, Open data. Linked open data. Shared data., Scientific Almanac of VFU, Mathematics and Computing Series, 4, 2018 г.
- [2] Brownlow Josh, Mohamed Zaki, Andy Neely and Florian Urmetzer. Data and Analytics - Data-Driven Business Models. Cambridge Service Alliance, 2015
- [3] A Brief history of Open Data, Available online <http://parisinnovationreview.com/articles-en/a-brief-history-of-open-data>
- [4] Ракитина-Куреша Е, „Свободен софтуер и операционни системи с отворен код“, Алманах на ВСУ, 2012
- [5] The European Union Open Data Portal (2018, 20.05. accessed). Available online <http://data.europa.eu/euodp/en/home>
- [6] Opendata barometer (2018, 4.06. accessed). Available online <https://opendatabarometer.org/4thedition/report/>
- [7] Иванова А., Гл Момчева-Гърдева, Анализ на практики с отворени данни, Научен алманах на ВСУ, Серия Математика и Информатика, кн. 4, 2018 г.
- [8] Open Data Portal of Estonia (2018, 20.05. accessed). Available online <https://opendata.riik.ee/en>
- [9] Момчева Г., Същност, интеграция и автоматизация с машъпи, Електронно списание на ВСУ e-JOURNALVFU, бр. 5, 2012
- [10] Schroeder, R, J. Halsall (2016). Big data business models: Challenges and opportunities. Journal Cogent Social Sciences, 2, 1.
- [11] Start-up Tracker - Start-up Britain (2018, 22.06. accessed). Available online <http://startupbritain.org/startup-tracker/>
- [12] Ракитина-Куреша Е., Отворена наука. Част 1 – отворени данни и софтуер с отворен код, e-Journal VFU, 2018
- [13] Андреев Е, Е. Дянкова, Ю. Цонев, Приложение на игровизация за повишаване на качеството на практическите занятия, Седма Национална конференция по електронно обучение във висшите училища, Боровец, 2018 г
- [14] Bakardjieva T., N. Lyutov, V. Spassova, Knowledge Management and Its Role in Higher Education, International Scientific Conference "Informatics in the Scientific Knowledge", 2010, June 24-26, Varna, Bulgaria, pp.319-325
- [15] Дамянов Д., Т. Бакърджиева, В. Спасова, Управление на знанията в адаптивните системи за електронно обучение, XVIII Национална научно-техническа конференция с международно участие АДП-2009, Сборник доклади, ТУ-София, стр. 74-79
- [16] Т. Атанасова, В. Спасова, Приложение на мултиагентните системи при вземане на стратегически решения в търговските фирми, Съвременни предизвикателства пред търговията, Унив. Изд. ИУ, Варна, стр. 439 – 445



# AUTOMATED MULTISTAGE FILTRATION DEVICE FOR ON-LINE LIQUID ANALYZERS

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**Abstract:** *A multistage filtration system has been conceptualized, designed, and prototyped. The system is suitable for various types of on-line liquid analyzers. The developed technology resulted to a low-cost, compact, flexible and reliable automatic system that is based on the use of common, low-cost filters combined with a novel, automatic filters replacement mechanism. A general overview of the device is provided and the design procedure that was followed is discussed.*

**KEYWORDS:** *LIQUID FILTERS, MULTI-STAGE FILTERING, ON-LINE LIQUID ANALYZERS*

## 1. Introduction

There is a large number of industries that rely on water or other fluids periodic quality analysis for meeting regulatory requirements or for ensuring safety and security for the population. One of the most typical examples is the drinking-water supply industry. Water analysis has become mandatory in residential, commercial, and industrial sectors, and thus water analysis instruments are used for determining the biological, physical, and chemical properties of water. Typically, water quality is assessed only in the laboratory. Samples of water are taken at certain intervals based on diverse regulations in different countries. Lab-based analysis methods of water quality are usually more reliable, but they cannot provide continuous information depicting the real-time data associated with water quality parameters. To safeguard public health, it is necessary to employ a system that can detect and respond to the changes instantaneously. This need has led to the development of real-time monitoring and on-line analysis of water quality, which has become a major trend in today's water analysis instrumentation market [1]. Likewise, the need for on-line analysis of water quality exists in the food industry and the aquaculture industry. The pharmaceuticals industry has similar needs and, in this case, not only for water quality analysis, but also for the analysis of other fluids used for pharmaceuticals production, such as various solvents.

One of the major problems when dealing with on-line fluid analysers is sample filtration. In fact, in the aforementioned examples, the sample cannot be used directly for the analysis. Pre-treatment is required, including a filtration step. Especially for field samples, this is critical since field samples are usually more contaminated than laboratory samples. It is not surprising that contaminants in field samples are reported to be the most frequent cause of problems with on-line analysers [2]. Furthermore, for on-line analysers, sample contamination is also a problem due to the frequency of the analysis. While a laboratory analyser might perform 100 tests a month, an on-line plant analyser could do 100 tests a day. Some technical solutions have been developed and used for overcoming this issue, including self-cleaning filters. Nevertheless, these solutions are very expensive and large in terms of size, thus useful only to specific application fields where cost and size might not be an issue. Most importantly, the lifetime of such solutions is still limited, while in many cases such filters cannot guarantee high retention rates.

Our project answers the need of the on-line analysers industry for a low-cost, compact, flexible and reliable automatic liquid sample filtering device. The overall objective of the project has been to design, develop and verify an automated multistage filtration concept to be used in various types of on-line liquid analysers. The developed prototype device is based on the use of common, commercial filters combined with a novel, automatic filters replacement mechanism and a smart, modular design for combining multiple filtration steps in a single process.

Herein, a brief description of the device is provided considering the limitations due to patenting issues. A systematic engineering

procedure was followed for the design of the system, which is also discussed.

## 2. Design procedure

The system was designed, and detailed engineering drawings were produced using computer-aided-design (CAD) tools. The dimensional compatibility of the individual parts was confirmed using 3D assembly models of the overall device. The CAD drawings were used for manufacturing the prototype through accurate computer-numeric-control (CNC) machining.

For the system development a systematic engineering design procedure was followed, as shown in Figure 1. The procedure starts with the definition of the problem followed by an extensive background research. A thorough market search was carried out and the results revealed that such a device does not exist in the market. It also became apparent that commercially available, filtration systems installed with on-line analysers need constant maintenance and filter changing intervention, which causes significant delays to the overall filtration process. Additionally, some of these on-line analysers, especially when filter changing has to be done in harsh conditions, are prone to error. Furthermore, frequent opening of the device for filter replacement may result to sample contamination.

The next design step was to identify the requirements for the system and prepare a list of specifications which served as a basis for the design (see more details below). Based on the design specifications alternative solutions were generated and systematically evaluated before selecting the most appropriate one, which was developed in detail. Engineering drawings were prepared using CAD software. The prototype was manufactured and then tested following a systematic evaluation procedure (see Section 3). Along the design procedure it was required to return to previous steps and iterate through the process until a satisfactory outcome was achieved.

### Design specifications

In general, the system is required to be customizable and adaptable to various application scenarios. The design process includes both the mechanical/electrical parts of the system, as well as the control system. The requirements/specifications also provided a basis for the testing and evaluation of the developed prototype. The requirements were grouped into certain categories:

- (1) Functional (multistage filtering operation, use of commercially available continuous filter paper, operation independent of paper porosity / thickness / manufacturer, compactness and transportability of device, high reliability).
- (2) Operational (reliable filter paper feeding, cutting, and disposal operations).
- (3) Usability (easy/quick installation of the device, intuitive and user-friendly interface, customizable).
- (4) Safety (safety-by-design, electrical and mechanical hazards both considered).

- (5) General (material selection to meet application requirements and manufacturability, minimize filter paper waste, labelling of cables and components for easy reference).
- (6) Control/actuation system (use reliable industrial control electronics and hardware, design to support integration with external devices and expandability).

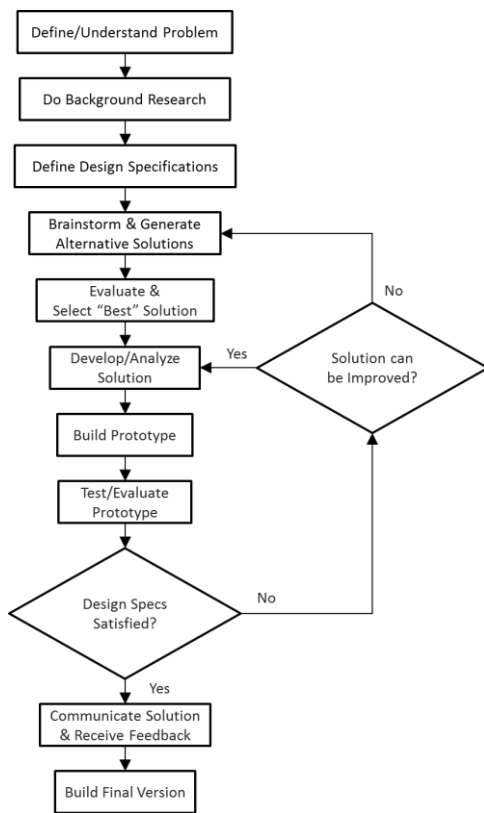


Fig. 1 General Design Procedure used for the design of the automatic filtering system.

### Materials Selection

The materials were selected based on functional criteria (liquid handling applications), structural requirements, cost and manufacturability. The main materials that were selected were both metallic (aluminum and stainless steel), as well as plastic (POM).

## 3. Description of the device

### Mechanical system

The mechanical system is composed of various subsystems that were integrated together: (i) Structural system (ii) Central multistage filtering module; (iii) Filter cutting; (iv) Filter advance and disposal; (vi) Liquids system. The individual parts are connected together using screws so that the system can be easily assembled and disassembled. Three motors are required for the operation of the device and correspond to the new filter supply system, the filter cutting mechanism, and the filter disposal. Stepper motors were selected for this purpose. The filter paper cutting is performed using a blade that is rolled over a cutting board. On the system it was also included an automated cleaning procedure, which can be performed between filtering cycles by passing water or other cleaning liquids through the system. The overall structure of the system is shown in Figure 2 that includes the mechanical, liquids, and control subsystems.

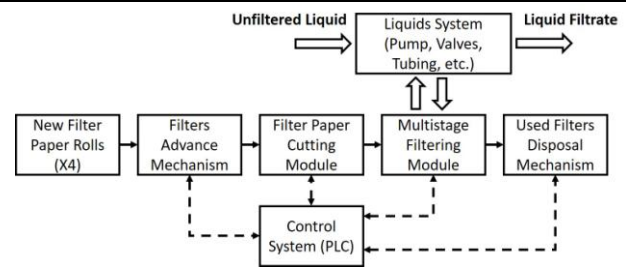


Fig. 2 Structure of the designed automatic filtering system.

### Control system

Control of the system is based on a programmable logic controller (PLC) which is a reliable and robust industrial option. User interface is implemented through a dedicated touch screen and a user-friendly, intuitive graphics environment. The user can change the functional settings, select between manual and automatic operation, and also test all individual functions of the device. The use of a PLC allows for flexibility and direct integration with other devices. The same PLC can also be used for controlling the pumps that direct the liquid through the filtering system, as well as any valves that may be involved depending on the application.

The general structure of the PLC-based control system is shown in Figure 3. The power supply unit provides the required 24V DC supply to the system. The PLC system comprises the central processing unit (CPU), the memory (where programs and data are stored), and the input/output modules. The latter receive sensory input and send control signals to the actuators (stepper motors), respectively. Communication with the user is via a touch screen and the screen menus that were designed for this purpose.

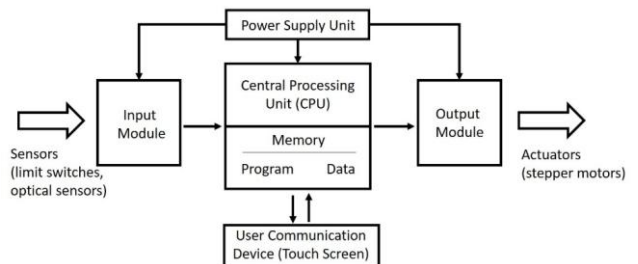


Fig. 3 Structure of the PLC-based control system of the automatic filtering system.

## 3. Testing procedure

Filtration performance is characterized by the pressure drop across a filter and the filtration efficiency. Given that the specific device uses commercial filters from reputable manufacturers, filtration efficiency is ensured. Testing focused on the overall operation of the device itself under realistic conditions.

Initially, various aspects of the device were assessed including the safety and the usability of the device (filter replacement and disposal process, user-friendliness and effectiveness of user interface). The operation robustness was verified by performing repeated cycles in automatic mode. Liquid was pumped through the system using a peristaltic pump, which can supply the required pressure. It was shown that the device can handle different liquid samples including sea water.

## 4. Conclusions

A multistage filtering system was designed, and the prototype has been developed and tested. A systematic engineering procedure was followed for the design. It is suitable for various types of on-line liquid analyzers and it allows automatic filter changes as well as an automated cleaning procedure. The operation of the system is user-friendly, and integration with other systems is straightforward.

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**References**

1. Global Water Analysis Instrumentation Market, Forecast to 2022, Ramprasad Manishankar, 2016 (<http://www.frost.com/sublib/display-report.do?id=P8F0-01-00-00-00>).
2. Filtering samples to on-line analyzers, Ken Perrotta et al., Parker Balston, 2013 ([https://www.parker.com/literature/Balston%20Filter/IND/IND%20Technical%20Articles/PDFs/Filtering\\_Samples\\_Online\\_Analyzers.pdf](https://www.parker.com/literature/Balston%20Filter/IND/IND%20Technical%20Articles/PDFs/Filtering_Samples_Online_Analyzers.pdf)).

# INFLUENCE OF ADDING SiO<sub>2</sub> NANOPARTICLES ON RHEOLOGICAL AND FILTRATION PROPERTIES OF WATER-BASED MUDS

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**Abstract:** Drilling mud is a working fluid which consists of a water and different added additives and is used during drilling of wells. By circulating through the wellbore, it ensures continuous cuttings removal, required pressure to stop the influx of reservoir fluid in wellbore, lubrication of drilling tools and maintaining wellbore stability while drilling through various types of formations. Since the well is often drilled through water-soluble rocks, which are mostly consisted of clay minerals, the penetration of the filtrate (water) into such rocks can lead to their destabilization, so the industry is considering the application of new types of additives because conventional additives, due to their size, can not enter in pores of rocks which has very low permeability, plug them and thus reduce further penetration of the filtrate. In recent years, scientists have paid great attention to the testing of nanoparticles (most tests are carried out with SiO<sub>2</sub> nanoparticles) for drilling through low permeability rocks. Nanoparticles are particles whose diameters range from 1 to 100 nanometers so they can enter into the pores and create a high-quality mud cake, thereby reducing the filtrate invasion and increasing the wellbore stability. This paper describes a laboratory test carried out with SiO<sub>2</sub> nanoparticles which average particle size was 20 and 60 nm added in concentrations of 1 and 3 wt% to water-based muds. Special emphasis was put on rheological and filtration properties. By optimizing the concentration and size of the used nanoparticles, the rheological and filtration properties of the used drilling muds were improved.

**Keywords:** SiO<sub>2</sub> NANOPARTICLES, DRILLING MUD, RHEOLOGY, FILTRATION, PPT, WELLBORE STABILITY

## 1. Introduction

Nanoparticles are particles whose diameter range from 1 to 100 nanometers, where 1 nanometer equals 10<sup>-9</sup> meters. Their significance along with the number of experiments conducted and field applications has been growing year by year. Additives and other materials which aren't usually used in the petroleum industry often get translated to the size of nanoparticles, and as such are added in the drilling mud, acquiring new properties or improving and speeding up their effects in the process. Fluids that contain nanoparticles are referred as nanofluids. Nanofluids are defined as suspensions of nanoparticles having an average particle diameter up to 100 nm [1].

Many previous experiments have been conducted on the topic of filtration properties of water-based muds using nanoparticles. For example, Vryzas et al. (2015) [2] discovered that iron oxide nanoparticles greatly reduce the filtration of bentonite suspensions. The largest filtration reduction of 42.5% in comparison to the base mud was observed in HTHP conditions using iron nanoparticles (0.5 wt.%) in a bentonite suspension. Using SiO<sub>2</sub> nanoparticles, all three concentrations (0.5 wt%, 1.5 wt% and 2.5 wt%) showed various reductions as well. On the other hand, Taraghikhah et al. (2015) [3] found that filtration properties remain the same using SiO<sub>2</sub> nanoparticles in concentrations below 1 wt%. Wahid et al. (2015) [4] used SiO<sub>2</sub> nanoparticles in a combination with synthetic mud at concentrations between 0.32 to 0.71 wt.%, showing a reduction in filtration and thickness of the mud cake, with stable and almost unaltered rheological properties. Salih et al. (2016) [5] found that the SiO<sub>2</sub> nanoparticles at low concentrations adjust rheological properties, such as yield point and gel strength, whereas if added to higher concentrations (more than 0.5 wt%) they have an adverse effect.

After searching the literature, a general conclusion can be drawn that the nanoparticles are used primarily to maintain filtration properties of the drilling mud because due to their large specific surface area they fill the fine pores in the mud cake formed on the borehole wall and reduce filtrate invasion in rocks, but in most cases they also have impact on rheological properties even their primary function is not to maintain rheological properties.

All of these experiments, combined with many others, indicate that there is still a lot to be done in the field of research of the effect that nanoparticles have on filtration and rheological properties in drilling muds.

## 2. Laboratory testing

Laboratory testing was performed at the Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Croatia. In order to better understand the impact of the addition of SiO<sub>2</sub> nanoparticles on the rheological and filtration properties of the drilling mud, two water-based drilling muds were chosen as base drilling muds. It was bentonite-based drilling mud (BM) and polymer-based drilling mud (PM). Preparation of base mud was carried out following American Petroleum Institute Standards, API Specifications 13A (1993) and API 13B-1 (1997) [6]. Bentonite-based drilling mud (BM) and polymer-based drilling mud (PM) formulations are shown in table 1 and 2.

**Table 1.** Bentonite-based drilling mud formulation (BM)

Base mud formulation	Quantity	Purpose
Water	-	base fluid
Bentonite	70 g/l	rheological and filtration properties
NaOH	2 g/l	alkalinity
PAC LV	2 g/l	filtration

**Table 2.** Polymer-based drilling mud formulation (PM)

Base mud formulation	Quantity	Purpose
Water	-	base fluid
XC polymer	3 g/l	rheological properties
CMC	6 g/l	rheological and filtration properties
CaCO <sub>3</sub>	50 g/l	weighthening material
KOH	1 g/l	alkalinity
KCl	20 g/l	weighthening material, swelling inhibitor

SiO<sub>2</sub> nanoparticles used in this research were in the form of an aqueous suspension, and were added to both based muds until nanoparticles concentration reach 1 wt% and 3 wt%. This type of nanoparticles were chosen because of their greatest distribution and ease of delivery. Two types of SiO<sub>2</sub> nanoparticles were used, nanoparticles which average particle size was 20 nm and 60 nm. Data on SiO<sub>2</sub> nanoparticles used for laboratory research are shown in table 3.

Table 3. Typical data for nanoparticles used in laboratory research

Brand name	JN-30	JN-4060
Manufacturer	JinWei Group	JinWei Group
Appearance	an aqueous suspension	an aqueous suspension
Nanoparticles content in aqueous suspension	30 wt%	40 wt%
Density of aqueous suspension @20° (kg/m <sup>3</sup> )	1 209	1 301
Average particle size (D50)	20 nm	60 nm
pH	9.6	9.8

Ten types of drilling muds were prepared and subjected to laboratory testing: two base drilling muds which formulation is shown in tables 1 and 2 and eight drilling muds contain SiO<sub>2</sub> nanoparticles, both types (20 and 60 nm) added in two concentrations, 1 and 3 wt%. In order to minimize the agglomeration of nanoparticles they were added slowly to base drilling muds and mixed for 30 more minutes.

After preparation of drilling muds, rheological and filtration properties were measured. The equipment and conditions are shown in table 4.

Table 4. Laboratory test equipment and conditions




Test	Equipment	Conditions
Rheology	OFITE Viscometer 900 	Atmospheric pressure, temperature 25, 50 and 75 °C
API filtration	API filter press 	Pressure 700 kPa, room temperature

Table 4. Laboratory test equipment and conditions (continue)

Test	Equipment	Conditions
PPT filtration	Permeability plugging tester (PPT) 	Diferential pressure 48.27 bar (700 psi), temperature 90 °C

3. Results and discussion

3.1. Rheological properties

Rheological properties were tested at 25, 50 and 75 °C using OFITE Viscometer 900. The following two figures show the relation of shear stress measured at shear rate of 5.1, 10.2, 170, 340, 510 and 1020 s<sup>-1</sup> according to American Petroleum Institute Standards, API Specification API 13B-1 (1997) [6]. Figure 1 refers to bentonite-based mud (BM), while figure 2 refers to polymer-based mud (PM).

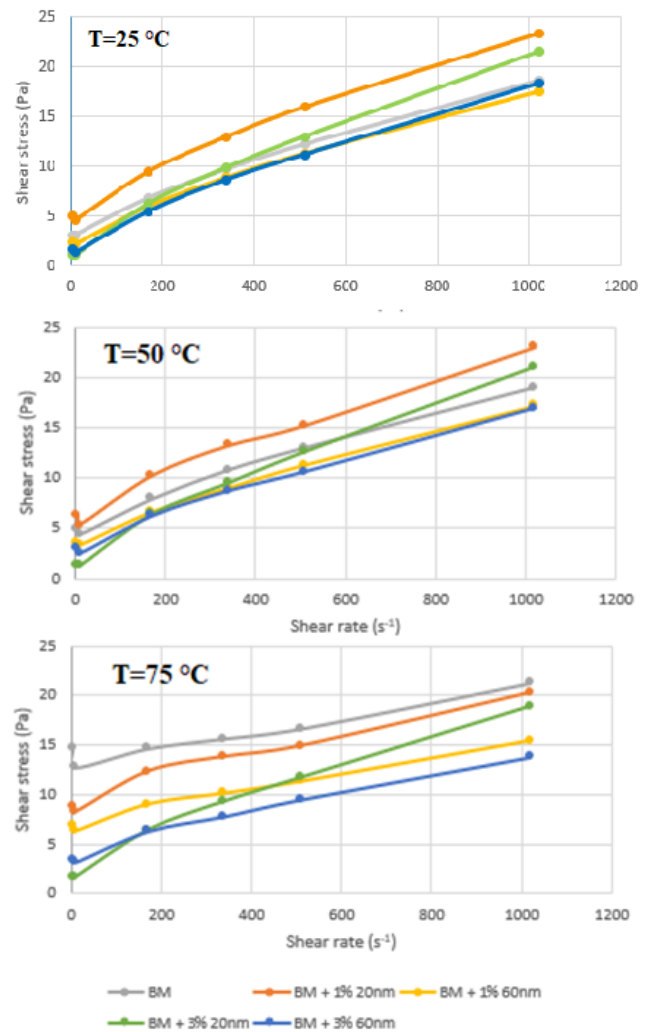


Fig 1. Shear rate vs shear stress of BM at 25, 50 and 75 °C [according to 7]

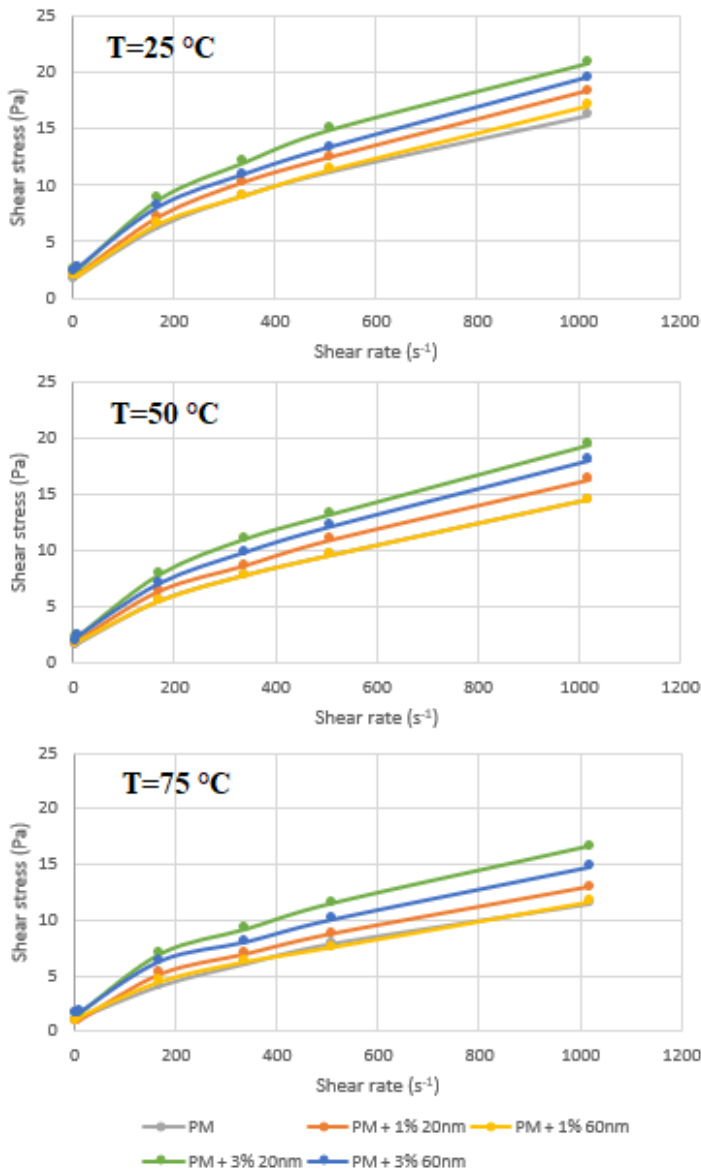


Fig 2. Shear rate vs shear stress of PM at 25, 50 and 75 °C [according to 7]

In bentonite-based muds, the lowest shear stresses measured at shear rates were obtained in mud which contain SiO<sub>2</sub> nanoparticles which has average particle size 60 nm added in both concentrations (blue and yellow line). In polymer-based muds the lowest shear stresses measured at shear rates were obtained in base mud without nanoparticles, while the highest shear stresses were measured in mud which contain SiO<sub>2</sub> nanoparticles which average particle diameter was 20 nm added in concentration of 3 wt%.

Also, as it was expected, by increasing temperature shear stresses values decreases for all tested muds.

### 3.2. API filtration

API filtration was carried out at standard API conditions at a pressure of 7 bar (100 psi) and room temperature according to American Petroleum Institute Standards, API 13B-1 (1997) [6]. Filter media was Whatman filter paper No. 50 and filtration area was 45,8 cm<sup>2</sup>. Test was carried out for 30 minutes, while filtrate volumes were recorded after 1, 5, 7.5, 10, 15, 20, 25 and finally 30 minutes. Table 5 shows the results of API filtration for bentonite-based muds (BM) and table 6 shows the results of API filtration for polymer-based muds (PM).

Table 5. Results of API filtration for bentonite-based muds [according to 7]

Time, min	BM	BM + 1% NP 20nm	BM + 1% NP 60nm	BM + 3% NP 20nm	BM + 3% NP 60nm
	Filtrate volume, ml				
1	1.5	2.5	2.5	1.5	2
5	4.75	4.5	5.5	4.5	4.5
7,5	5.5	5.75	6.5	5.5	5.5
10	6.5	6.5	7.25	6.5	6.5
15	7.75	7.75	9	8	7.75
20	9	9	10.25	9	8.75
25	10	10	11.5	10.5	9.75
30	11	11	12.5	11.5	10.5

Table 6. Results of API filtration for polymer-based muds [according to 7]

Time, min	PM	PM + 1% NP 20nm	PM + 1% NP 60nm	PM + 3% NP 20nm	PM + 3% NP 60nm
	Filtrate volume, ml				
1	1.5	1.5	1	1.5	1.5
5	4	4	4	4.75	4.5
7,5	5.5	5	5	6.25	6
10	6.5	6.5	6	7.5	7
15	8	8.25	7.25	9.75	8.75
20	9.5	9.75	8.5	11.5	10.5
25	10.5	11.25	9.75	13.25	11.5
30	12	12.5	11	14.75	12.5

For bentonite-based muds, as shown in Table 5, the only drilling mud with nanoparticles that reduced the filtrate volume in comparison to the base bentonite-mud (11 ml) was the mud that contained 3% NPs 60 nm, by a slight margin of 0.5 mL, while the worst results were achieved by the combination of 1% NPs 60nm (12.5 ml).

The only polymer-based mud with NPs that showed improvement was the one containing 1% NP 60 nm (11 ml), reducing the amount of final filtrate by 1 mL. The rest of combinations of added NPs aggravated the volume of filtrate in comparison to the base polymer mud (12 ml), while worst was those with 3 wt% 20 nm (14.75 ml).

### 3.3. PPT filtration

PPT filtration was carried out using a Permeability Plugging Tester (PPT) at 90 °C. The experiment was performed with a differential pressure of 48.27 bar (700 psi), where the constant inlet pressure equaled 68.95 bar (1000 psi), while the outlet pressure amounted to 20.7 bar (300 psi). Filtration was performed through the ceramic disc which has a permeability of 0.75 μm<sup>2</sup> (750 mD). Tables 7 and 8 show the amount of measured filtration after 7.5 and 30 minutes and calculated amounts of Standard Filtrate Volume (VPPT) and Spurt Loss (V<sub>1</sub>) of bentonite and polymer-based muds

respectively. The PPT device has a filtration area of 22.9 cm<sup>2</sup>, half the area of a API filter press so the total volume should multiply by 2 [8]. Also, Spurt Loss is the amount of filtrate collected before the mud cake has formed, expressed in ml.

Standard Filtrate Volume (V<sub>PPT</sub>) and Spurt Loss (V<sub>1</sub>) can be calculated using the following equations [8]:

$$V_{PPT} = 2 \times V_{30} \tag{1}$$

$$V_1 = 4 \times V_{7.5} - 2 \times V_{30} \tag{2}$$

Where:

V<sub>7.5</sub> – Filtrate volume collected after 7.5 minutes

V<sub>30</sub> – Filtrate volume collected after 30 minutes

V<sub>PPT</sub> – Standard Filtrate Volume, ml

V<sub>1</sub> – Spurt Loss

**Table 7.** PPT filtration after 7.5 and 30 minutes and calculated Standard Filtrate Volume and Spurt Loss of bentonite-based muds [according to 7]

	BM	BM + 1% NP 20nm	BM + 1% NP 60nm	BM + 3% NP 20nm	BM + 3% NP 60nm
V <sub>7.5</sub>	15	13	13	16.5	13.5
V <sub>30</sub>	21.5	20.5	20.5	25	21.5
V <sub>PPT</sub> , ml	43	41	41	50	43
V <sub>1</sub> , ml	17	11	11	16	11

**Table 8.** PPT filtration after 7.5 and 30 minutes and calculated Standard Filtrate Volume and Spurt Loss of polymer-based muds [according to 7]

	PM	PM + 1% NP 20nm	PM + 1% NP 60nm	PM + 3% NP 20nm	PM + 3% NP 60nm
V <sub>7.5</sub>	18	14	11.5	15.5	12
V <sub>30</sub>	26.5	23	18.5	27	22
V <sub>PPT</sub> , ml	53	46	37	54	44
V <sub>1</sub> , ml	19	10	9	8	4

The values of Spurt Loss and filtration after 7.5 minutes were reduced in every mud with nanoparticles in comparison with their respective base muds, except for the BM + 3% NP 20nm. Filtration after 30 minutes, as well as the total filtration, was reduced in all muds with nanoparticles except for the BM and PM with 3% NP 20nm.

**4. Conclusion**

The examination of the impact of adding nanoparticles to drilling muds has been growing year by year. However, it is mostly referred to many laboratory tests with few field applications. In this paper were used SiO<sub>2</sub> nanoparticles which has different particle size and was added in different concentrations. The best result of the reduction of the final filtration volume during the measurement of PPT filtration was achieved by polymer-based drilling mud with nanoparticles which average particle diameter was 20 nm added in

concentration of 1 wt%, while the smallest value of the Spurt Loss was achieved by polymer-based drilling mud with nanoparticles which average particle diameter was 60 nm added in concentration of 3 wt%. The lowest value of API filtration was measured in bentonite-based drilling mud with nanoparticles which average particle diameter was 60 nm added in concentration of 3 wt%.

However, in these conducted tests, few combinations of different nanoparticles added in different concentrations proved to be more successful, while some other combinations were more unfavorable during the same experiments. Therefore, based on these tests, it is not possible to extract one or more drilling muds that are generally shown to be the best, but it is necessary to continue testing on this subject with new nanoparticles added in different concentrations.

**5. References**

[1] Ilyas, S. U., Pendyala, R. and Marneni, N., *Preparation, sedimentation, and agglomeration of nanofluids*, Chemical Engineering & Technology, 37(12), 2011-2021, 2014.

[2] Vryzas, Z., Mahmoud, O., Nasr-El-Din, H. A., Kelessidis, V. C., *Development and Testing of Novel Drilling Fluids Using Fe<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub> Nanoparticles for Enhanced Drilling Operations*, IPTC-18381-MS, International Petroleum Technology Conference, Doha, Qatar, 2015.

[3] Taraghikhah, S., Kalhor Mohammadi, M., Tahmasbi Nowtaraki, K., *Multifunctional nanoadditive in water-based drilling fluid for improving shale stability*, International Petroleum Technology Conference, 2015.

[4] Wahid, N., Yusof, M. A. M. and Hanafi, N. H., *Optimum nanosilica concentration in synthetic based mud (SBM) for high temperature high pressure well*, SPE/IATMI Asia Pacific Oil & Gas Conference and Exhibition, Society of Petroleum Engineers, 2015.

[5] Salih, A. H., Elshehabi, T. A., Bilgesu, H. I., *Impact of nanomaterials on the rheological and filtration properties of water-based drilling fluids*, SPE Eastern Regional Meeting, Society of Petroleum Engineers, 2016.

[6] API, R. 13B-1, Recommended Practice for Field Testing Water-Based Drilling Fluids, and ISO 10414-1, American Petroleum Institute, 2003.

[7] Mijić, S., *Utjecaj nanočestica SiO<sub>2</sub> na smanjenje filtracije isplaka na bazi vode*, Master thesis, University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, 2018.

[8] OFI Testing Equipment, Inc., *Permeability Plugging Tester #171-193: 115 Volt #171-193-1: 230 Volt Instruction Manual*, Ver.5.0, Houston, Texas, USA, 2015.

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