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REVIEW OF FACTORS AFFECTING OPTIMAL NUMBER OF CAVITIES FOR INJECTION MOLDING OF POLYMERS

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A b s t r a c t: The industry for designing and manufacturing of molds for injection molding very often faces with problem regarding optimization of number of cavities in the mold. The modern CAD and CAE can be very helpful in this process. Designer has to satisfy several parameters in regards of decreasing the costs and manufacturing time. For this purpose modern software tools are available such as SolidWorks, Master CAM and SolidWorks Plastics. This paper contains multiaspect analysis for molded plastic part manufactured to be cover element of HVAC. Factors such as production rate needs, especially mold design and costs for its manufacturing, are analyzed in this paper. Their influence on selection of optimal number of mold cavities is explained.

Key words: injection molding; mold design; mold cavities; cost analysis

ПРЕГЛЕД НА ВЛИЈАТЕЛНИТЕ ФАКТОРИ ЗА ИЗБОР НА ОПТИМАЛЕН БРОЈ ГНЕЗДА ПРИ ИНЈЕКЦИОНО ЛЕЕЊЕ НА ПОЛИМЕРИ

А п с т р а к т: Индустријата за конструирање на алати за инјектирање на пластична маса многу често се соочува со проблем за правилен избор на бројот на гнезда во алатот. За олеснување на изборот се користат современите програми CAD и CAE. Конструкторот има неколку параметри кои треба да ги запази додека се конструира алатот, за да се добиле помала цена и пократок временски период на изработката. За овој процес се користат програмите SolidWorks, Master CAM и SolidWorks Plastics. Тука се дава анализа од повеќе аспекти на конструкција и изработка на украсен дел наменет за HVAC. Трудот дава насоки на кој начини може да се намалат трошоците во поглед на цена и времето на изработка.

Клучни зборови: инјекционо леење; конструкција на алат; гнезда; анализа на трошоци

INTRODUCTION

The manufacturing of polymer products is one of the most profitable sectors in the global economy. A great number of polymer products are produced annually worldwide. On the basis of the research of the modern market needs, it was concluded that most of the polymer products (known as plastic products) are manufactured in plastic injection molds (or just injection molds). From the wide range of tools, the tools for injection should provide: long-term use, high durability and resistance to chemical reactions [1, 2]. For this purpose, attempts are made to reduce the cost of design and development of these tools by using more standardized parts. In the designing of tools for injection of polymeric material, one of the main goals of the designer is to produce the optimal number of cavities in the molds. This is done in order to reduce the manufacturing cost of the mold, but at the same time to meet the manufacturing needs of the required parts. In the manufacturing of injection tools, costs are a very important economic category that is most directly linked to the profits and success of the company's operations. Development of technology and software packages has led to their full integration in the manufacturing process. One of the most important features of the CAD/CAM modeling systems is the ability to personalize or customize the program according to your needs, depending on the complexity of the task. Also, independent input of the mold's properties, as well as manipulation of the basic specific models, has been introduced.

INJECTION MOLDING

The injection molding procedure is one of the most exploited methods of manufacturing polymeric material articles nowadays. Injection molding depends largely on the size, complexity and the number of cavities in the injection mold. The injection process occurs in several stages that are shown in Figure 1-1.

The injection pressure is very high, within the limit of 500 to 3000 bar [3], but the process can also be carried out with higher pressure, up to 10000 bar (Figure 1-2). The speed of injecting melted plastics is high and in some cases is up to 1.5 m/s [4]. When melted plastics enters mold cavity, which is at lower temperature, it cools down. This is precisely defined by the processing conditions. The pressure in the mold cavity is lesser than the pressure of the injection, and it is within the limits of 300 to 600 bar (Figure 1-2). When the mold is filled completely, the machine pressure is additionally increased in the injection cylinder (Figure 1-3).

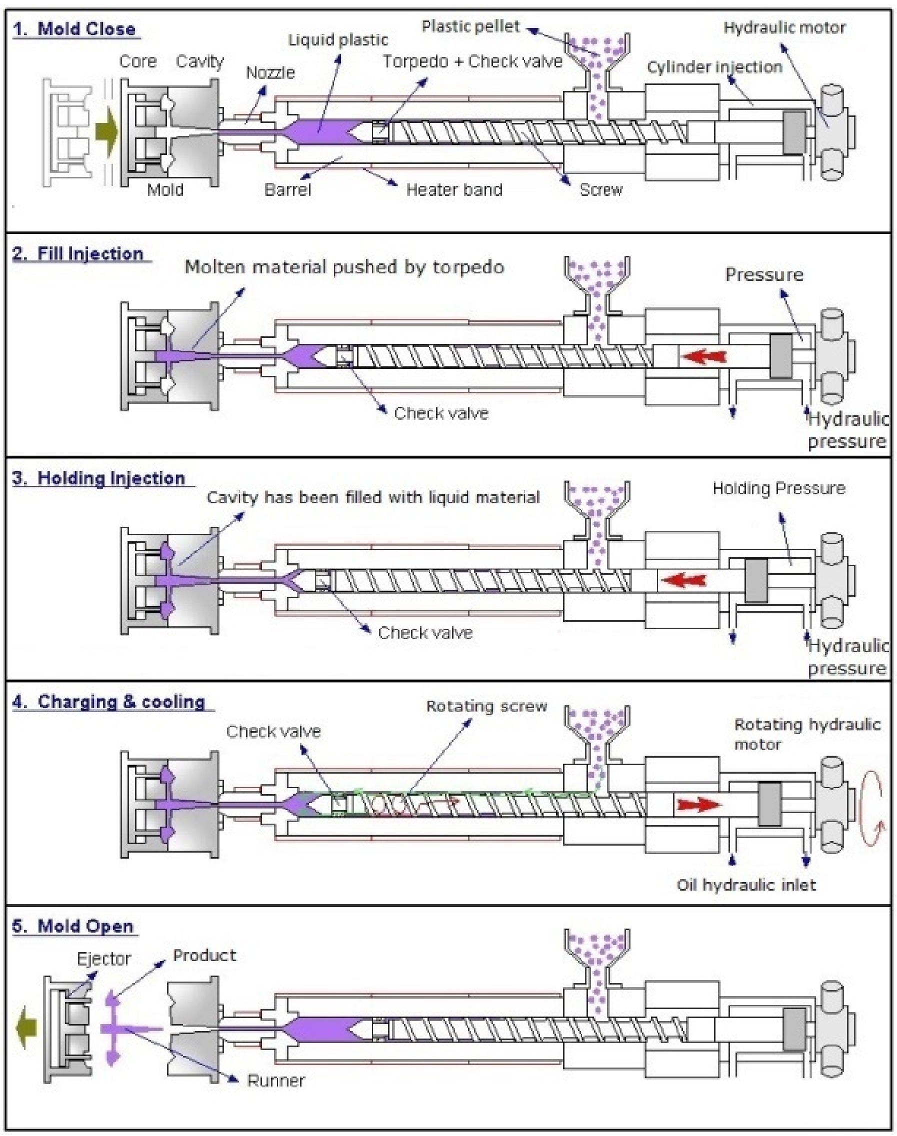


Fig. 1. Stages of injection molding

Additional pressure acts in a way that assists solidification of the gate (cavity entrance) between the mold cavity and the input system. Thus, it is possible to remove the nozzle from the runner system and the process of solidification to begin. The time needed for cooling down (Figure 1-4) of the molded part is often longer than the filling time (Figure 1-2), applying additional pressure (Figure 1-3), solidification time and removal of the nozzle [5]. The cooling down of the molded article is achieved by using a special device for releasing heat in the mold, through a use of system of cooling lines circulating water or oil part of the mold. When the molded material hardens, the mold is opened (Figure 1-5) by separating the movable from the stationary part and the part is usually pressed out with a system of mold ejectors.

Tools for injection molding

Components of the injection mechanism are shown in Figure 2.

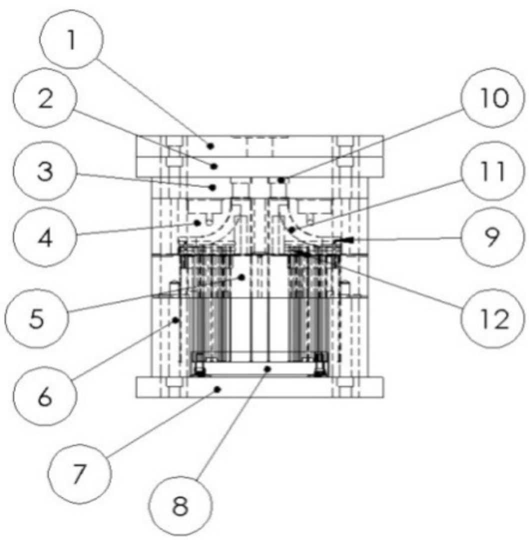


Fig. 2. Components of molding mechanism
1 –2) Upper stationary plate; 3) Upper supporting plate; 4) Upper mold forming plate; 5) Lower mold forming plate; 6) Tie rods; 7) Lower movable plate; 8) Ejection package; 9, 10, 11, 12) Mold base formers

The tool designing process is very complex and includes a large number of activities. Determination of the number of cavities is one of the most important. For this purpose it's crucial to obtain the following parameters from the production [6]:

- Number of units that should be manufactured H_B;
- Dead line for unit manufacturing m;
- Duration of machine cycle m_C;
- Working hours efficiency coefficient η.

Parameters used in this paper are given in Table 1.

Table 1

Production parameters used in the research

H_B (units)	m (days)	m_C (h)	η
500000	200	40/3600	0.9

Very important aspect which relates to selection of number of mold cavities is injection machine itself. Mold machine is defined by the injection weight. If it has high weight capacity, than it is expected the number of mold cavities to be optimized for it.

It's assumed that the specific month has 21 working days, and work is conducted in one 8 hours shift.

$$H_\sigma = \frac{H_B}{m} = 2500 \qquad (1)$$

H_C is number of molded parts that needs to be manufactured in one day.

$$n_{cd} = \frac{8 \cdot \eta}{m_c} = 648 \qquad (2)$$

n_{cd} is number of cycles that can be realized in one day.

$$H_{bl} = \frac{H_\sigma}{n_{cd}} = 3.9 \qquad (3)$$

H_{bl} is number of cavities in the mold according to production requirements in ideal circumstances.

INFLUENTIAL FACTORS

The optimal performance of the mechanisms for injection molding should be designed so that a quality product is obtained, and, on the other hand, it should decrease the expenses for the manufacture of the finished product.

Design aspects

Before manufacturing of tool itself, injection simulation is performed in SolidWorks Plastic. This facilities the design of tool and gives final product with the highest quality. Simulating this process before cutting the tool, allows changes to be made early on, ultimately saving money and optimizing results.

According to eq. 3, preliminary number of mold cavities is equal to 4. Additionally, with simulation in SolidWorks Plastic, the tool design is verified from filling point of view-uniform filling. Ununiformed filling causes problems with the part quality. The results from the simulation are shown on Figures 3 and 4.

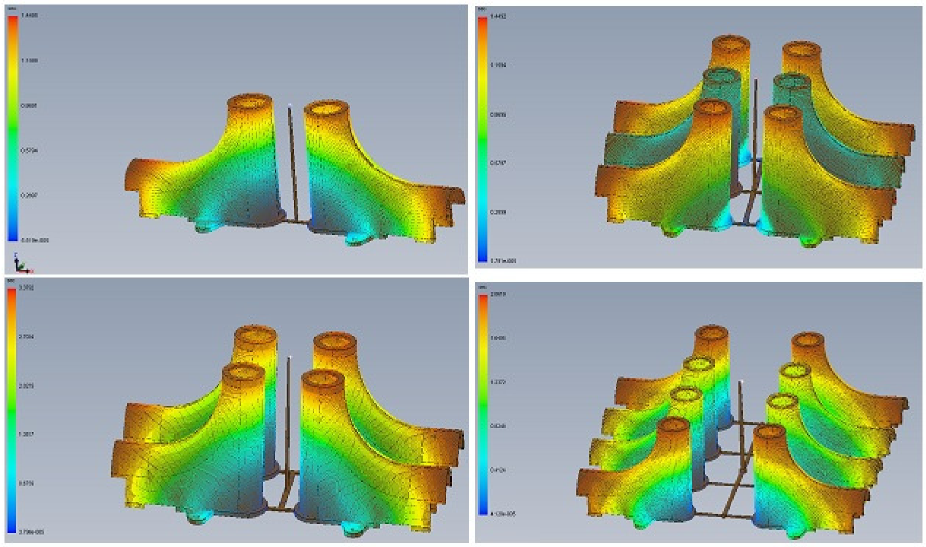


Fig. 3. Simulation results (cooling rates)

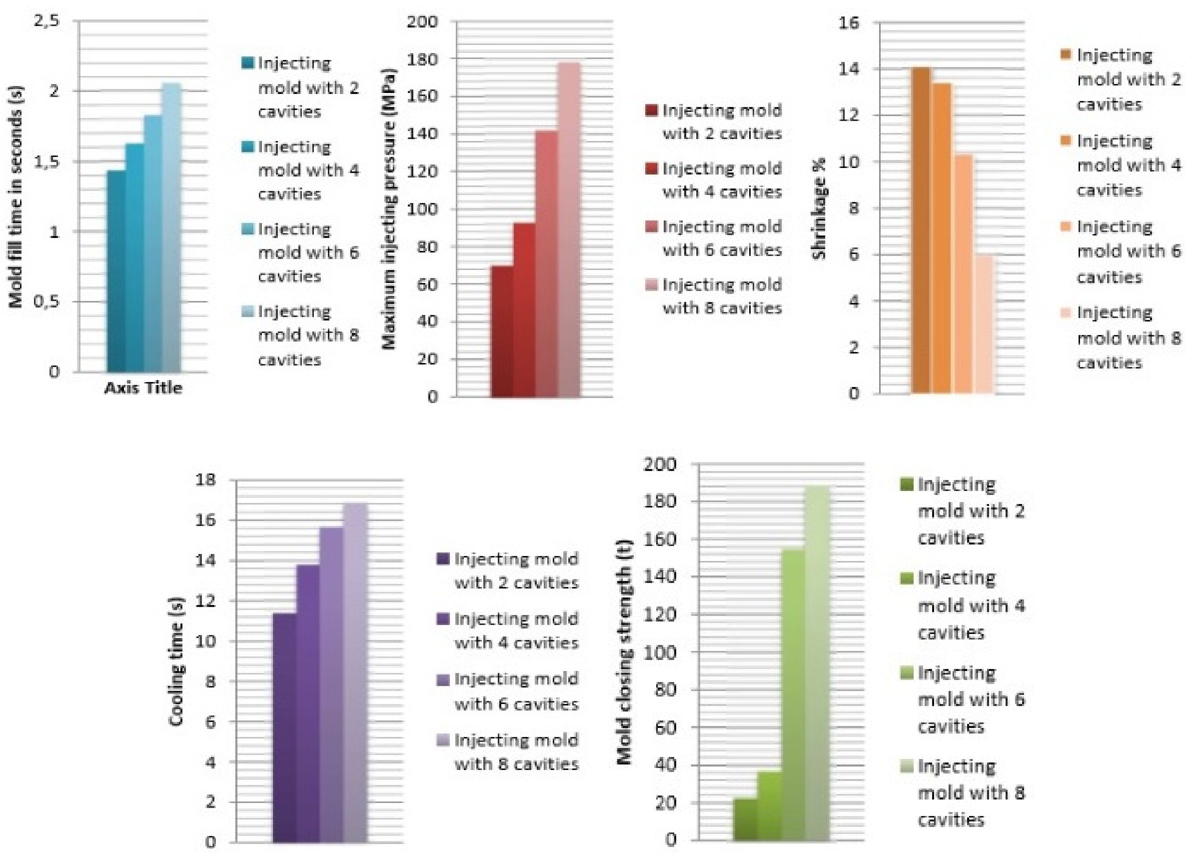


Fig. 4. Results for 2, 4, 6 and 8 mold cavities

From the results (Figure 4) can be seen that optimal parameters are achieved for 4 mold cavities. Increase of number of cavities has large influence on mold closing strength and material shrinkage; necessary strength increases and shrinkage is decreased. The cooling and fill time increases in proportion with the number of cavities. In order to successfully control the injection of plastic part, it is recommended the mold temperature to be 60°C, the temperature of the melted plastic to be 230 °C. Also, increase of thickness in the critical areasis recommended.

Tool cost (REFA methodology)

Planned calculation serves to determine value of plastic injection tool. Two types of costs are included:

- Direct costs are the one that occur during direct molding of the product;
- Indirect costs are costs which are not incorporated in the product, i.e. can't easily be determined for each product:

$$C_c = M + L_d + A + O_{tr}, \quad (4)$$

where C_c is total cost; M are costs for materials; L_d are costs for manufacturing of individual parts; A are amortization costs; O_{tr} are general costs.

Calculation of the total price	
Upper stationary platen	400.oo MKD
Supporting plate 1	400.oo MKD
Supporting plate 2	740.oo MKD
Upper mold forming platen	33 210.oo MKD
Lower mold forming platen	11 439.oo MKD
Ejection package	1 383.oo MKD
Tie rods	1 383.oo MKD
Lower stationary platen	400.oo MKD
Forming segments 1	8 610.oo MKD
Forming segments 2	1 383.oo MKD
Forming segments 3	2 460.oo MKD
Total cost:	61 808.oo MKD
Manufacturing time needed for the two cavities molding tool is 10 days.	

Fig. 5. Two cavity mold calculation total cost

With the help of technological processing list, used here for calculation, work is greatly facilitated and time is saved when preparing the CAM programs. The technological list specifies the types of treatment that should be conducted to obtain the required surface, and we also define the type of tool that we will use, its diameter, number of teeth, and processing mode.

A calculation of the costs for manufacturing the two cavities mold is provided in Figure 5.

A calculation of the costs for manufacturing eight cavities moldis provided in Figure 6.

Calculation of the total price	
Upper stationary platen	400.oo MKD
Supporting plate 1	400.oo MKD
Supporting plate 2	1660.oo MKD
Upper mold forming platen	132 840.oo MKD
Lower mold forming platen	4 321.oo MKD
Ejection package	1 500.oo MKD
Tie rods	1 383.oo MKD
Lower stationary platen	400.oo MKD
Forming segments 1	31 057.oo MKD
Forming segments 2	5 381.oo MKD
Forming segments 3	15 260.oo MKD
Total cost:	234 602.oo MKD
Manufacturing time needed for the eight cavities molding tool is 35 days	

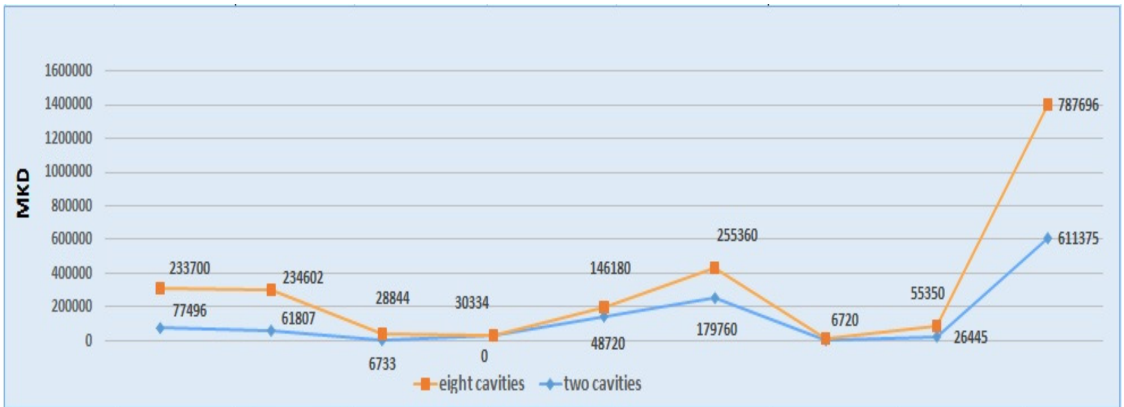
Fig. 6. Eight cavity mold calculation and total cost

Comparative analysis

Apart from material selection and geometry definition of the product, key element in manufacturing of an injection mold is the choice of the optimal number of cavities. The examples with different number of mold cavities included in the paper show that by using certain "rules" when developing an injection tool, improvement can be accomplished in all stages. It should be noted that selected number of cavities defines the final cost of the tool (Table 2). Multiaspect analysis defined in this paper is beneficial in a way that decrease the time necessary to prepare offer, and in the same time, more accurately predicts the costs of all elements included in the offer. Finally, the prediction of the real costs for the material, processing of parts, defining the number of cavities, as well as the objective time frames for conducting individual operations affects delivery dead lines.

Table 2

Comparison of partial and total costs for two and eight cavities in injection molds



	Procurement of material	Production of platen	Amortization of the machine for the production of the mold	Amortization of the injection mold tool	Amortization of the injection mold machine	Electricity consumption of the injection mold machine	Consumption of the coolant	General costs	Total price
two cavities	77496	61807	6733	30334	146180	255360	5040	26445	611375
eight cavities	233700	234602	28844	0	48720	179760	6720	55350	787696

CONCLUSIONS

Manufacturing of molds for parts obtained by injecting polymer materials is a truly complex task and a challenge for each engineer-designer of molds. Multiaspect analysis contributes so that manufacturing of the part will be done in a timelier, more accurate, more secure and more quality manner. The expected results from such an organized manner of manufacturing of tools by using numeric stimulation will:

- decrease the tools manufacturing costs,
- decrease the duration of the manufacturing process and delivery of products;
- increase the quality of the entire manufacturing process.

Milling machines (CNCs) have important role in the process. They are used for manufacturing of injection mold tool.

If basic principles and above listed conclusions for selection of the optimal number of cavities are neglected, mold manufacturer would lose it is competitiveness on the market.

Finally, general conclusion is that the optimal number of mold cavities is function of the injection mold machine capacity (weight), fill design of the mold tool (filling channels distribution in the tool) and expected production rates. Last one is in relation with the injection mold machine capacity.

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Original scientific paper

ADVANTAGES OF DIGITAL LIBRARY FOR MANUFACTURING INJECTION MOLDING TOOL OVER INDIVIDUAL FABRICATION

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A b s t r a c t: This paper is an overview of the possibilities for the use of standard elements in modeling of injection tools. It covers the use of digital library and how this affects achieving greater efficiency, speed, and significant decrease of the number of errors. A comparison is made with personal individual production. By applying such a flexible system, we save time and money and a better quality is guaranteed. This type of manufacturing by using standardized elements from a digital library is a new type of system that improves overall manufacturing process of injection molding tools.

Key words: injection molding; standardized tools; digital library

ПРЕДНОСТИ НА ДИГИТАЛНАТА БИБЛИОТЕКА ЗА ИЗРАБОТКА НА АЛАТ ЗА ИНЈЕКЦИОНО ЛЕЕЊЕ ВО ОДНОС НА ПОЕДИНЕЧНА ИЗРАБОТКА

А п с т р а к т: Овој труд е преглед на можностите за употреба на стандардни елементи при моделирање на алат за инјектирање. Се разработува начинот на работа со дигиталната библиотека и како тој влијае врз постигнување поголема ефикасност, брзина и значително намалување на грешките. Споредбата е направена со сопствено поединечно производство. Со примена на ваков флексибилен систем се заштедуваат време и пари и има загарантиран подобар квалитет. Овој начин на конструирање со стандардизирани елементи преку дигиталната библиотека претставува нов систем кој ја подобрува изработката на алати за инјектирање.

Клучни зборови: инјекционо леење; стандардизирани делови; дигитална библиотека

INTRODUCTION

Most of the many technologies available for manufacturing parts made out of polymer materials are used in the injection molding process, i.e. the manufacturing of injection molding tools [1]. The development of computer systems in the last decade raised the need to create modern computer technological systems that greatly facilitate the job of the designer. Serial production or great wear and tear resistance are just a part of the characteristics that injection-molding tools should possess [2]. By applying high standards as mandatory prerequisites for the design, a quality final product can be expected. In order to maintain the production quality of tools, and simultaneously save money and time, standardized tools are utilized that offer security in the use based on strict quality control.

CHARACTERISTICS

Injection molding tools are expensive to make and are most frequently used for mass production. They are made of hardened steel, pre-hardened steel, aluminum and/or beryllium-copper alloy [3]. The selection of material depends greatly on the production series. The molds are manufactured by machining, EDM, CNC milling, wire cutter machine. The finished mold surface is often polished and coated to resist wear and aid in part ejection.

The final mold design can be prepared only after the part design has been specified and all requirements affecting the design of the mold have been clarified (Figure 1).

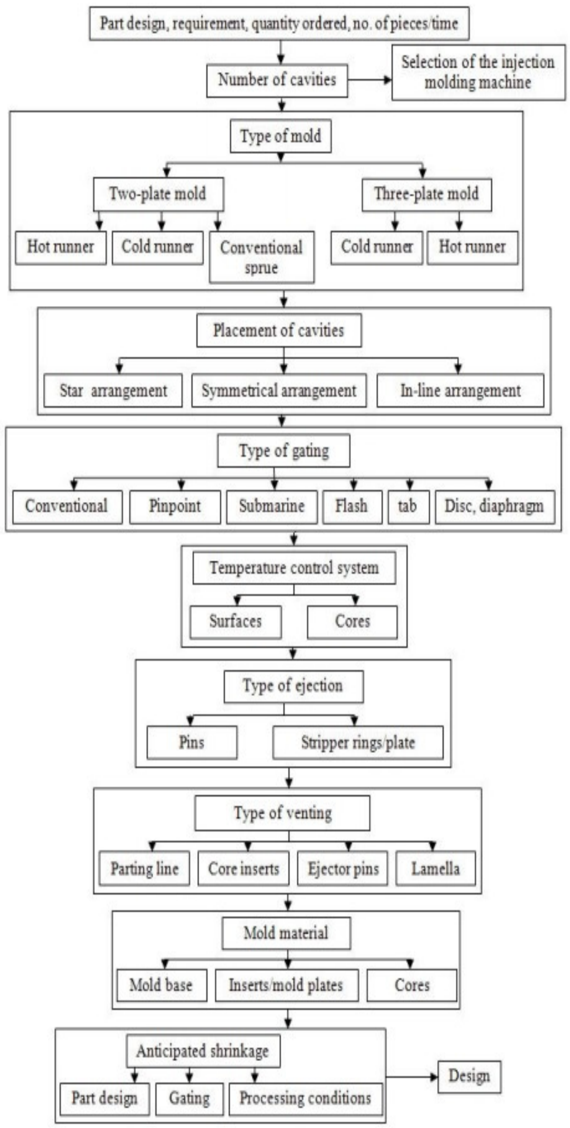

Fig. 1. Structure for the selection of parts in the injection tools

Composite parts of the injection tools

Main functional elements of the injection tool are shown on Figure 2:

- Stationary part where the tool receives the material dosage (Figure 2-1).
- Movable part, from whence the final product is ejected from the tool (Figure 2-2).

Other usual components [4] of the injection-molding tool are: injection bushing-nozzle (1), clamping plate (2), upper stationary plate (3), upper cavity plate (4), lower cavity plate (5), rear cavity plate (6), spacer blocks (7), ejection package (8), leader bushing (9) and leader pins (10)

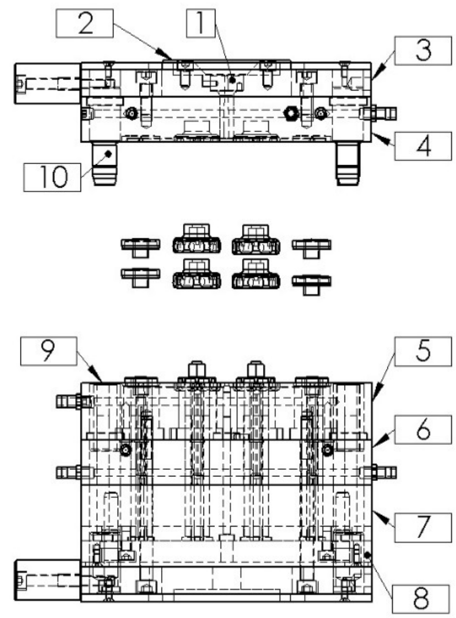

Fig. 2. Composite elements of the injection molding tool

Digital library – use and characteristics

Digital library provides a lot of useful informations, regarding the design and the technical aspects. It has two main functions, on one hand it is an interactive catalogue for quick and easy ordering of materials, and on the other hand it maintains the CAD link with a complete 2D and 3D models of all the products offered by the company (Figure 3). If necessary, the data can be generated in a certain needed format (STEP, IGES, DXF).

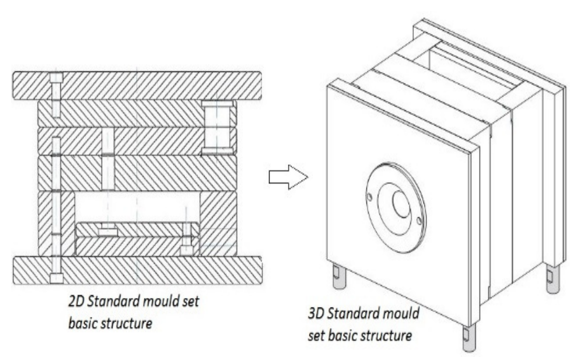

Fig. 3. 2D and 3D model

Figure 4 shows the process of selection of standard elements and the communication of the digital library with the CAM program, Solid Works. For the selection of elements needed for the injection tool (plates, bushings, pins, leader pins, sprue bushing) the digital library uses the sub-program DAKO to establish the link to the CAM program SolidWorks.

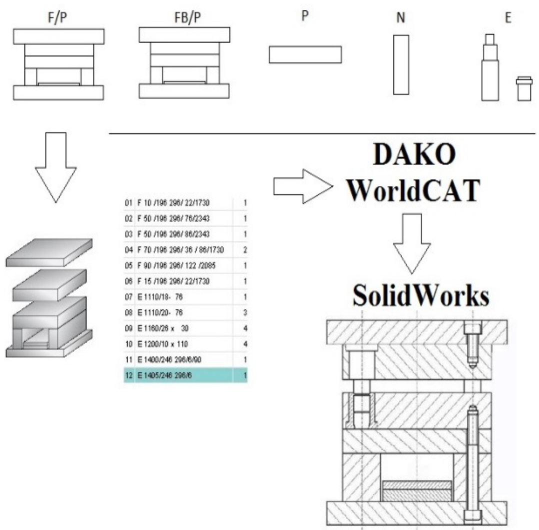

Fig. 4. Choosing standard parts for manufacturing of the injection tool

MANUFACTURING WITH DIGITAL LIBRARY

General consideration that to be need taken into account when designing the tools from scratch, can be systematized into:

- Design and material of components;
- Number of cavities in the tool;
- Type of tool;
- Selection of an injection machine;
- Correct choice of a parting line;
- Positioning of core and cavity;
- Correct positioning of the cavities in the tool;
- Part ejection system;
- Cooling (heating) system;
- Fool proofing arrangements;
- Good choice of material for manufacturing of the tool for longer use.

The list above shows the complexity of the problem when design and fabrications are individual.

To save cost, common mold components are purchased from suppliers. Frequently, outside services are required from subcontractors, which use specialty equipment such as thread grinding, etc. When all of the parts are completed, the next step is to fit, assemble and test the mold. All mold component parts must fit together precisely to achieve an aesthetic result on the product and for the mold to not wear out rapidly or break. The mold must be fluid tight to contain the molten plastic. Yet, at the same time the mold must have venting features added to allow the air to escape (Figure 5).

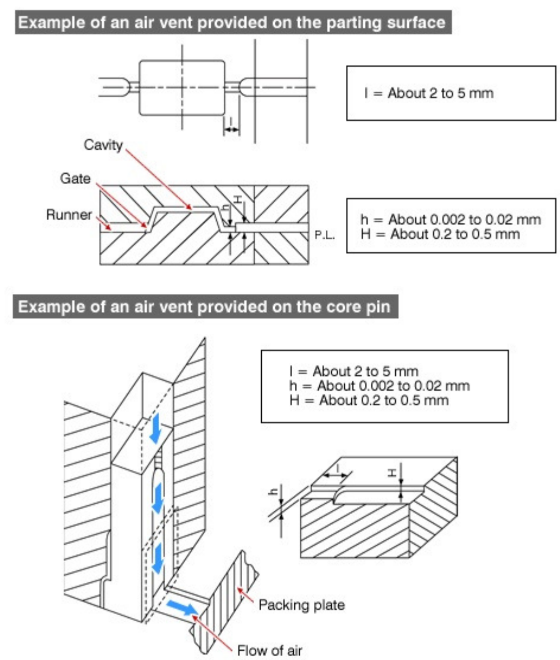

Fig. 5. E xample of an air vent

It is clear that every tool depends on the dimensions of the part, the number of cavities in the tool and the machine where it shall be injected. One basic requirement must be met by every mold that is intended to run on an automatic injection molding machine is that the molded parts must be ejected automatically without the need for secondary finishing operations (degating, machining to final dimension, etc). An ejection is very required in order to eject the cured component from the tool without causing any damage to the component. The design of the ejection system is one of the major factors of how efficiently the tool will be in production [5]. Above all, by using a digital library and standard elements for tools design, the work of the designer is facilitated, because the only thing that is needed is the design of the tool cavities, the ejection package and the cooling system. The remaining elements are automatically generated from the digital library.

COMPARATIVE ANALYSIS OF COSTS

Comparative analysis was done by comparing the price for fabrication of two plates from the injection tool, where one has been ordered ready made from the digital library of standard elements and the other has been customized by us. What would the advantages and disadvantages be if a custom fabrication is made? To complete this analysis we shall take into consideration the upper stationary plate and the front cavity plate. Also, it has to be mentioned that this analysis is conducted with Macedonian prices. The dimensions of the upper stationary plate and the top forming plate are given in Figures 6 and 7.

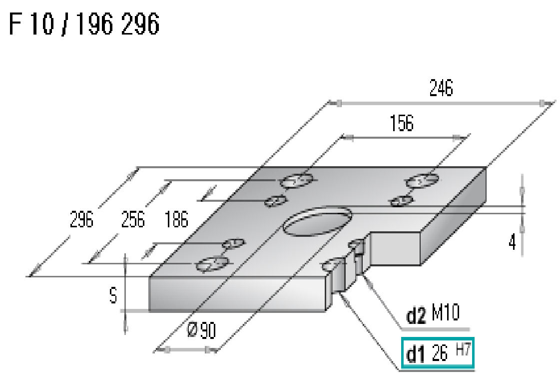

Fig. 6. Dimensions of the upper stationary plate

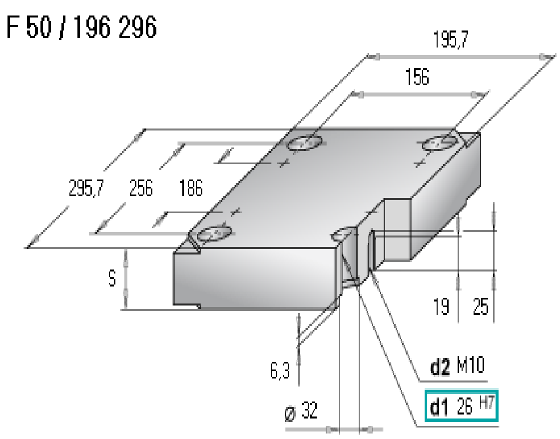

Fig. 7. Dimensions of upper cavity plate

The regular [6] manufacturing technology is systematized in the following procedures:

- Cutting the material;
- Thermal treatment improving 640 N/mm^2;
- Tenoning with a grinding insert;
- Flat grinding;
- Rough drilling of 4 cavities F26N7;
- Manufacturing of 4 threads M10;
- Coordinates grinding F26H7.

Table 1 and Table 2 show the prices of each fabrication procedure individually, for the fabrication of plates are shown in Figures 6 and 7.

Table 1

Calculation of upper stationary plate's costs

Material: DIN C45U (1.1730 tool steel)			
Operation	Cost per kg (€)	Total kg	Total price (€)
Procurement of material	0.65	9.5	6.2
Thermal treatment	2	9.5	19
Operation	Cost per working hour (€)	Duration of production	Total price (€)
Tenoning	15	3	45
Coordinates grinding	15	3	45
Total costs (custom)	/	/	115
Total costs (standard)	/	/	105

Table 2

Calculation of upper cavity plate's costs

Material: DIN 40 CrMnMoS 86 (1.2312 tool steel)			
Operation	Cost per kg (€)	Total kg	Total price (€)
Procurement of material	5	34.5	172.5
Thermal treatment	2	34.5	69
Operation	Cost per working hour (€)	Duration of production	Total price (€)
Tenoning	15	4	60
Coordinates grinding	15	4	60
Total costs (custom)	/	/	361
Total costs (standard)	/	/	240

Figure 8 shows the total results. The difference in price can be seen in the individual production and the selection of a readymade standard part, the latter being more cost effective.

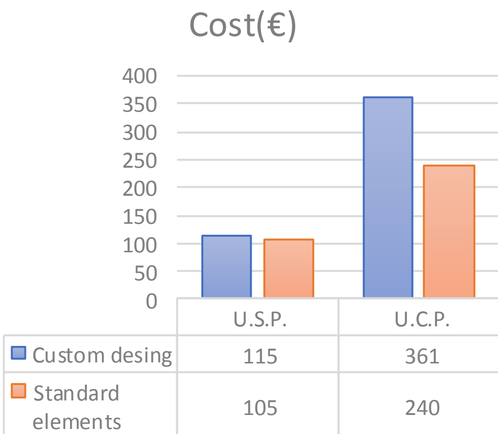

Fig. 8. Comparison of the price of the upper stationary plate and the upper cavity plate

CONCLUDING OBSERVATION

With the rapid technological progress, companies that need certain tools, also have the ever-present demand for quality tools, duration, price and visual appearance. When manufacturing of a tool composed of custom designed elements, the following problems may occur:

- Due to the custom design, one can't always find the needed material quality, which causes the need to search for a replacement.
- The lack of a machine park leads to the cooperation with subcontractors which increases the analysis time and control of elements.
- The thermal processing regarding the term is a problem.
- In custom designing, the elements are not always produced in accordance with the requested quality, and they are being adjusted in the assembly of the tool, which causes a lower quality in the final product.

If the manufacture the tool using standard elements from the digital library:

- Material quality is always guarantied.
- A large amount machining equipment is not needed for the manufacturing of tools,
- Reduced working with subcontractors.
- Strict quality control.
- The time needed to manufacture the tools is much shorter.
- They are visually on a higher level.

The price of tools can always be a topic of discussion with companies which ordered the tools, but the same does not apply to the time needed for the manufacturing and the quality of the tools.

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Original scientific paper

CREATING A CONCEPTUAL INNOVATION MODEL FOR DEVELOPMENT OF THE COMPANIES

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A b s t r a c t: Innovations, nowadays, are part of a company's everyday life. These activities, aimed at improving overall performances, sustaining and developing of companies, are always subject to change. The manner of addressing these issues in order to maintain competitive advantage is, in fact, the innovative activity we should apply in business surroundings. Innovation processes are relatively complex and they require proper systematization or using tools or structure, whereby adequate would be implemented in a particular company. In this context, we create a conceptual innovative model for development of the companies.

Key words: innovation; idea; creativity; sustainability and development; collaboration; innovation model; innovation management

КРЕИРАЊЕ НА КОНЦЕПТУАЛЕН ИНОВАЦИСКИ МОДЕЛ ЗА РАЗВОЈ НА КОМПАНИИ

А п с т р а к т: Иновациите, во денешно време, се дел од секојдневниот живот на компаниите. Овие активности секогаш се предмет на промена во насоката на подобрување на севкупните перформанси, одржување и развој на компаниите. Начинот на решавање на овие прашања, со цел да се одржи конкурентна предност, всушност се иновативни активности кои треба да се применуваат во бизнис-околината. Иновациските процеси се релативно сложени и тие бараат соодветна систематизација или пак користење на алатки или структура, за што посоодветно да се спроведат во определена компанија. Во овој контекст се создава концептуален иновациски модел за развој на компаниите.

Клучни зборови: иновации; идеја; креативност; одржливост и развој; соработка:, иновациски модел: управување со иновации

1. INTRODUCTION

Innovations are one of the most important company endeavors to maintain and develop themselves. Changes are inevitable, and they, through one innovative working environment, can contribute to continuous improvement and achieving the strategic goals.

While creating an innovative work environment, we must, first of all, to explain the basic principles, i.e. definition and classification of innovations, which in turn, will help us for their fundamental understanding and the most convenient interpretation of the same. The value, which they provide and parameters inherent for innovative companies, accentuate the exceptional importance in implementing and managing change. Also, we will introduce the opportunities regarding protection of innovation, through patenting them and adding additional value for enterprises.

Particular reference will be given to the innovative activities of business entities in the Republic of Macedonia, according to relevant statistics and will highlight their weakest performance in such a creative process. The existence of ideas that would generate a certain competence value for companies is not the most important segment of innovating, but their management and evaluation, while making the right decisions, are the main elements of an innovative business organization.

Complexity, in providing expertise for innovative aspirations, consists in making the right decisions, by increasing creativity in business environment, encourage innovation, idea generation and their communication and refining, managing and measuring performance and building model, which most appropriately interpret all mentioned criteria, supported by the high level of the company's collaboration circles. Such a model will mainly target innovative activities to solve specific problems or create exceptional opportunities in order to develop and improve the company's performance.

The research aims to:

- Defining innovation and their impact on the success of the companies;
- Highlighting crucial issues for implementation of innovative processes at companies in the Republic of Macedonia;
- Creating an innovative conceptual framework / model, for developing and improving the company's performance.

The methodology of implementation, according to the objectives set, as follows:

- Defining, analyzing and presentation of the characteristics and classification of innovation;
- Innovative activities of companies in Macedonia according to statistical data of the State Statistical Office, European Commission and Knowledge Center;
- Systematized approach to encourage and guide the innovation processes by selecting the appropriate model;
- Conceptual innovative framework, for managing, evaluation and proper implementation of the innovation process.

For the purposes of research and methodological approach outlined in this paper, expected results include:

- Perceiving and self-awareness of the meaning and importance of innovation, to maintain and develop companies;
- Creating an innovative conceptual framework / model for continuous balanced management and evaluation, regardless of the industry in which the company participates;
- By introducing of the innovative processes, to provide support in achieving its goals for a competitive edge and development;
- Improve the overall performance of the company, by reducing costs, reducing the time frame for exit at the market, increased productivity, efficiency, sales, profits and other indicators;
- Creating a creative and dynamic work environment, infiltrated in the mental structure of everyone involved, i.e. employees.

INNOVATION AND PATENTS

There are quite definitions of what is an innovation, all directed to the most appropriate emphasis on their importance for companies and the benefits they provide themselves. In addition, will be revealed a few:

- Innovation is something new, triggered by the opportunity or idea, which is followed by appropriate changes which are inevitable, providing value and improved performance for the organzation.
- Innovation does not only apply to non-existent and completely new product or service, but cover a variety of aspects of the everyday operation of enterprises, whether it is a new technology, a new method or a new process. We should think of innovation in the sales process, ongoing production process or the ongoing marketing process. All of that represent an innovation.
- Innovations are the changes which add value and are supported by continuous improvement. They represent the exploitation of the opportunities for creating a difference on the market and competitive advantage. Innovations have multiple forms and can co-exist, be interactive and to build on with each other as part of an ecosystem, or as part of an value-economy [2].

Classification of innovation

For the most appropriate specification of innovative perspectives and highlighting the enormous opportunities, provided by such activities, in the sequel, we will mention only a few basic divisions of innovation, by which we will further explain better the aspirations to establish and create a dynamic conceptual innovative framework of action.

The categorization also helps in the measurement of innovation, enabling comparison of performance and recording or evaluation of decision making that may lead us to a real improvement or timely generating the best solutions for return of funds, depending on the investments themselves.

Generally, there are four types of innovations: *product innovation, process innovation, organizational innovation* and *marketing innovation* [3].

According to different impact of innovation, or the scope itself, common types are: *partial innovation, radical innovation and transformational innovation* [1].

Depending on whether there is cooperation on external entities, i.e. increased collaboration in approaches for implementation of innovations, we may classify them as ***closed innovation (without cooperation)*** or ***open innovation (active cooperation).***

Throughout history, with time, evolved a variety of innovative models for monitoring and managing innovation processes, from a ***linear model***, ***"technological push" and "market pull"***, ***cyclic innovation model***, right up to the ***"Stage-Gate" model***, for whom we will talk more broadly in this paper.

Patents

When we talk about innovation and their significance, it is necessary to mention the importance of protecting them and the possibility of patenting, toward adding an additional value for a business organization.

A patent is a monopoly right granted by a national or regional patent office to an inventor who has created something new, useful and non-obvious; e.g. an innovation in the pharmaceutical sector that results in a new headache pill or a new technology used in computer hardware. Obtaining a patent to cover an invention or new technology enables its creator to prevent others from using, selling, manufacturing or otherwise copying the innovation without permission for a limited period (generally 20 years, subject to the payment of maintenance fees). In return, the patent owner discloses details of the innovation behind the invention as part of the patent application, thereby ensuring that the technology enters into the public domain where it can be used freely once the patent expires [4].

By providing the patent owner with a legal means to prevent others from exploiting the protected invention, patents provide a crucial method for inventors to obtain a return on the investment in research and development that led to the creation of that new technology. In general, patents will also help to prompt further innovation in the sector, as rival companies seek to develop their own solutions or technology to retain their competitive edge [4].

Patents do not protect an 'idea'; it is the tangible description or realization of that idea (e.g. drawings, prototypes or records of the research) that allows an idea to become an invention that is capable of protection. Only products or processes that contain or possess new functional or technical aspects can be patented. This could be an entirely new product, an enhancement to an existing product or a new or improved process [4].

Similarly, an invention must fulfil certain criteria of patentability. This can differ according to the country or region in question but, in general, will include the need for the technology to be:

- 'New' – does the invention already exist (e.g. has it already been created by another inventor)? Has the inventor already disclosed the innovation (e.g. through publication) anywhere in the world before the application date. If so, it will not meet this criteria of novelty [4].
- Obtained as a result of the activity of invention ('inventive step') – this requirement will generally have been fulfilled if, when comparing the invention to what is already known, the innovation would not be obvious to someone with experience and knowledge of the subject matter of the invention [4].
- Capable of industrial application – the invention or new technology must be capable of being used in a current technical application, so that it can be made or used in some kind of industry, i.e. it must have a practical application [4].
- Most national patent systems also restrict or block from patenting, discoveries in certain

areas; e.g. scientific theory and mathematical methods; computer programs as such; new animal or plant varieties; and methods of treatment and diagnosis [4].

A patent is not a right to practice or use the protected invention; instead, it provides the right to exclude others from doing so. As such, the emphasis is on the patent owner to monitor for misuse and to enforce the right via infringement action where misuse is found [4].

A patent is an item of (intellectual) property and, like any other property right, may be sold, transferred, licensed, mortgaged, given away or simply abandoned [4].

Additionally, patent protection may allow us a strong market position, high return on investment, increased negotiation power or positive image of our company.

INNOVATIVE ACTIVITY OF THE COMPANIES IN MACEDONIA

Innovation as a concept does not represent a "gray area" for the companies in Macedonia, but still, creation and maintenance of a modern innovative enterprise is a major challenge.

According to the survey, conducted by the State Statistical Office, during the period of 2010 – 2014, in terms of innovative activities in the companies, statistical data are released, on how many, where, and how much influence they have to prosperity or maintenance and development of enterprises.

Therefore, we may observe (Table 1) that companies in Macedonia (from 2012 to 2014) innovate relatively little or only 34.8% by SMEs of total number of innovative enterprises in the country. Which means that 65.2 % of innovations are made by big companies, but still, they are not so much involved, considering the total number of business entities in the Republic of Macedonia.

Table 1

Business entities by innovations and size 2012 – 2014 [5]

Size	Total	Innovative		Non-innovative	
		Number	%	Number	%
Small	2 333	774	33.2	1 559	66.8
Medium	549	230	41.9	319	58.1
Large	115	75	65.2	40	34.8
Total	**2 997**	**1 078**	**36**	**1 919**	**64**

Also, it is obvious that innovation activities are mainly related to the product or process, organization or marketing and very small percentage of them practice the both types, ie only 19.1% (Table 2) of the total number of enterprises.

Table 2

Business entities by types of innovations 2012 – 2014 [5]

Section	Product and process innovative		Organizational and marketing innovative		Product/process and organizational and marketing innovative	
	N	%	Nº	%	Nº	%
Total	400	37,1	386	35,8	206	19,1

In the table of sales markets, however (Table 3), impact of innovation on market competitiveness and market advantages is evident, compared to those who do not undertake and implement such a concepts. Thus, the percentage of sales, outside the country (global market) for innovative companies is significantly higher, unlike to non-innovative.

Table 3

Markets of sale of products/services 2012 – 2014 [5]

	Innovative business entities				Non-innovative	
	P		O			
	NÇ	%	Nº	%	Nº	%
Local/regional market	137	34.3	133	34.5	546	28.5
National market	243	60.8	274	71.0	557	29.0
EU and EFTA markets	221	55.3	251	65.0	652	34.0
Other countries	195	48.8	207	53.6	163	8.5

P = Products and process innovative;
O = Organizational and marketing innovative

As we can see from Table 4, in relation to the cost of innovation activities, companies in Macedonia are investing mostly for the purchase of equipment, machinery, software and buildings or 59.5% of total cost and the least for collaborative activities, i.e. cooperation and gaining knowledge from other enterprises, only 0.8%.

It speaks a lot about conservativeness in the exchange of information and new knowledge between companies, which certainly hampers and reduces the possibilities of creating a fully committed and innovative working environment, striving for continuous improvement and development of the organizations.

Table 4

Expenditures for innovation activities in 2012 [5]

	Expenditures for innovation activities (%)				
	1	2.	3.	4.	5.
Total	6.4	21.4	59.48	0.8	11.9

1. = In-house R&D.
2. = External R&D
3. = Acquisition of machinery, equipment, software and buildings
4. = Acquisition of existing knowledge from other enterprises or institutions
5. = All other innovation activities including design, training, marketing and other relevant activities

In that context, in Table 5, will be presented statistical data on cooperation of innovative companies in the country and their relations with other enterprises and institutions.

Table 5

Innovative business entities with or without active innovation co-operation with other business entities or institutions, 2010–2012 [5]

Cooperation	Product innovative	Process innovative	Product and process innovative
With active cooperation	34.6 %	32.1 %	43.1 %
Without cooperation	65.4 %	67.9 %	56.9 %

We can notice, that whether it comes to improving and/or developing a new product or process, active cooperation with other business entities or institutions in the field of innovation is significantly lower, compared to innovation without cooperation, which certainly is a field that needs to be paid special attention, in order to increase opportunities through the collaborative activities of enterprises.

In addition, we will briefly refer to another research done by Knowledge Center (Research and Management Company, based in Skopje) for the period from 2010 to 2013.

Thus, 2/3 of the companies in Macedonia invested in innovative activities to develop new products and services, investing mostly in equipment, machinery and technology, or an average of about 12,000 euros per year. Of those, only 31.4% invested and introduced a new and significantly improved production processes while 13.7% have not done any intervention in its operational processes [6].

Macedonian companies despite the fact that they are investing and starting new projects, they did not commercialize innovations and nearly two-thirds of its revenues come from old and existing projects, only 13% comes from products/services that are new to the company and about 20% of products that are new to market [6].

But the fact that 52% of companies abandoned some innovative projects in the period from 2010 to 2013 is the biggest concern [6].

The conclusions of these surveys indicate that the companies in Macedonia have increasingly innovative thoughts and activities but they succumb in the implementation and realization of the same. In this exact context, in addition, we will create an innovative model or an strategy that as a concept may be easily adaptable to any business environment and provide appropriate management and evaluation, monitoring and managing innovative processes in order to achieve its goals.

CONCEPTUAL INNOVATION MODEL

When creating an innovation business environment, the flow of information and ideas is of critical importance. That, in itself, requires an exceptional level of collaboration. Generating ideas is also the key cog in these processes as well as choosing and polishing them. This plays an important role in innovations as a whole. However, the management and monitoring of these creative processes in order to reach the most appropriate decisions for solving actual problems or identifying possibilities through worthwhile changes for the company, has to be supported through a model, i.e. a structure that enables us to lead them.

Models and classifications for managing innovations were mentioned previously. The choice mostly depends on the company's structure, its aims, the industry, the community, the market, as well as the strategic goals of the business itself. All these parameters refer to the choice of the innovation model, and this choice represents a "tool" that helps us make the most appropriate decisions regarding innovations.

For us to be able to create a dynamic innovation working environment, first of all we need to have the convenient conditions, meaning to apply certain methods and principles for increasing the creativity and encourage innovation in the company. Therefore, we need to enable a high level of collaboration (both internally and externally), self-expression, freedom of expression and sharing of ideas, conquer the fear of change, face the challenges and try to find opportunities which offer chances to increase the value. We need to be flexible, break routines, hold "brainstorming" meetings, follow customers' interests and ask questions of the community and the competition, recruit competent and skilled personnel and to have a dynamic suggestion scheme.

Features and benefits required by innovation model

An appropriate innovative model seeks to provide representation, which can help in understanding and functioning of everything related to bussines environment. Some of the attributes that should be considered in an innovative model are as follows [7]:

- **Simplicity –** whether the model is easy to understand and use?
- **Descriptively –** does it provide a detailed explanation, simile or kind of imitation (while using)?
- **Measurable** – whether the model allows you to measure and provides evaluation of alternatives?
- **Predictability –** when assumptions of the model are correct, whether it provides itself adequate probability for prescribed outputs?
- **Timeliness –** whether the model provides evaluation, measurement and insights that offer innovative opportunities in a certain time frame, which will lead to success?

To have available innovative model, which represents some kind of leverage, i.e. facilitates and provides an understanding of the changes, can make a huge difference in the longer term, considering survival and progress of the business.

An effective model [7]:

- Provides a conceptual framework (structure / plan / base) and promote innovative thinking;
- Helps earlier identification of new sources of innovation;
- Allows better timing of market introduction;
- Assists in finding innovative opportunities related to the time frame required for business operation;
- Decreases the probability of competitive disruption;
- Increases the return on innovation investment;
- Improves the ability for anticipation, i.e. prediction of innovation necessary;
- Maintains competitive advantage and enables long-term evolution.

Innovation model for managing and implementation of innovation processes

Innovations promote the need for constant change and rebuilding and thus influencing all areas of the business. The possibility to increase the business' value through innovations is the key driver behind the success of most organizations. Markets in which, we enter to compete or maintain competitiveness offer possibilities but also risks, due to fast alterations.

As stated earlier, the innovation model offers a conceptual framework to identify and further develop ideas for change, which have the biggest chance to generate value required to maintain growth. Of course, the best model is the one which best fits the culture and there market where it's being used, the products/services offered and the business' model as well as the organization itself.

The most appropriate model for developing and an innovation working environment or organization, with the general features required such as simplicity, describability, measurability, predictability and punctuality as well as the support it gives for reaching the best decisions would be the "Stage-Gate" model (Figure 1).

"Stage – Gate" is a business' process that creates values but it's also a certain risk model, designed for quick and profitable transformation of the best organizational ideas in actual products or services [8].

"Gated" innovation models/processes are cross-functional in their nature, they require a high level of coordination and communication in every segment of the business (sales and marketing, research and development, operativeness, finances, etc.) to provide suitability or reach the best possible solution or decision.

Decisions, completed on each port, basically, need to support the changes in a process that the organization required and thus leading to the organization's success.

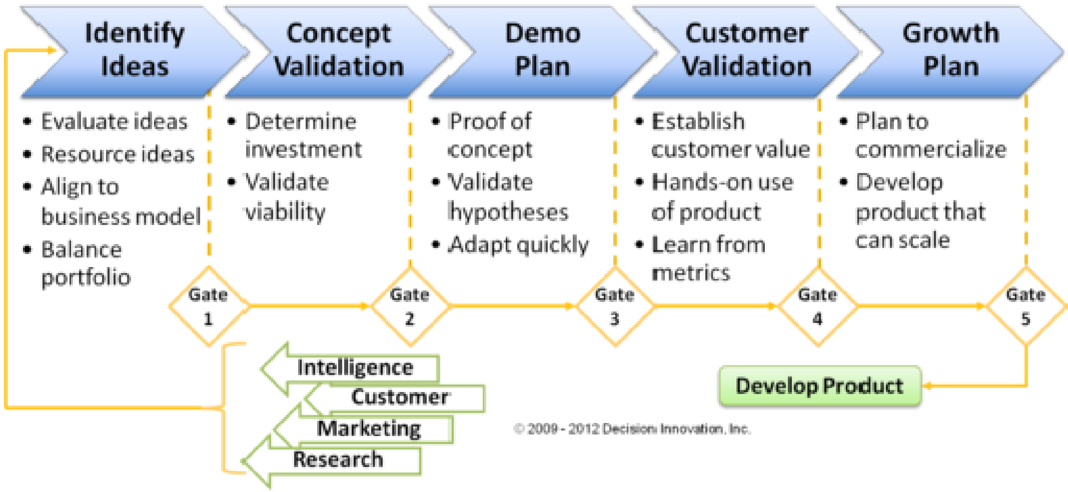

Fig. 1. "Stage-Gate" model for managing innovation processes [8]

Each successive gate in the innovation funnel reduces uncertainty that would prevent additional investment. The decisions made provide evidence of meeting established factors needed for success. Factors that facilitate change are increased while factors that work to resist change are reduced. Needed communication and education are built into the process [8]. Research and activities in each "stage" results in an appropriate decision in the next "gate" to proceed with process or stop the same or, in some cases, return to the previous "stage" and refine it, in order to provide great conditions for continuous innovation activities, i.e. innovation process, respectively:

- **Idea identification** – Ideas are evaluated for further resourcing. Criteria will often demonstrate the ability to be accommodated in the current business model, although spinoffs may be supported. Balance must be developed that will promote promising ideas while preventing being overwhelmed by evaluation of too many ideas [8].
- **Concept validation** – The concept is developed enough to determine the investment needed to validate key elements of viability such as value proposition, competitive advantage, and likely returns [8].
- **Demonstration development plan** – A plan is developed to provide a proof of concept demonstration to customers. For startups, this could be a product that might be used with non-paying customers. This plan will seek to minimize investment needed to validate key hypotheses with targeted customers. A demonstration vehicle that can accommodate quick and low cost requirements changes will accelerate the learning process [8].
- **Customer value validation** – The value to the customer is established through their interactions with the demonstration product. Metrics that show causality will provide the learning that will continue to reduce uncertainty [8].
- **Growth plan – commitment to commercialize** – For businesses with an established business model, the plan for full commercialization is developed. This may be the entry business gate to the more predictable (knowable risks) development process. For newer businesses, investment is made to develop a product that can scale as business grows [8].

An innovation model such as this one, implemented and used in particular organizations, enables an innovation framework to take us through the process where every successful "gate" in the innovation "funnel" reduces the uncertainty. This uncertainty could in turn, lead to additional and unwanted investments, thus increasing the costs of the whole process.

Additionally, the model increases the communication between those who are involved. The communication has to be at the highest level to enable the creation of innovation value, both for the customers and the organization.

The possibility of archiving the evaluated outcome and the suitable polishing throughout the process, as well as, their reuse, improves the security. In other words, it reduces the risks, which of course, enables positive performance of the system in general.

First of all, we should establish what it is that we want to improve and where, meaning which business segment will be subject to change. That is to say, establishing is a clear vision and target is necessary.

Multiple factors can help define the aims which are interconnected and most frequently based on:

- problems or failures of the current state,
- customers' demands,
- competition pressure,
- self-initiative for innovation and growth.

The first factor, ***problems or failures due to the current state***, emphasizes an already existing starting point in the direction of changes and improvement and they can refer to: increased expenses, decrease in sales, decrease in manufacturing, decrease in profits, dated technology, staff changes, etc.

The formal methods for defining and solving problems could lead to improving as well as increase the creativity and thoroughness of analyzing possibilities which would reduce business risk and improve innovations.

These issues encourage a fitting innovation change, meaning that increased expenses will initiate innovation that will lead to their decrease by evaluating the financial portfolio and detecting the area where they are the biggest (suppliers and resources, manufacturing, marketing, services, sales, research and development, management etc.).

Customers' demands is one of the most wanted scripts of a innovation company ideally has built good communication with its clients. These demands can refer to: improved quality, improved convenience, improved services, timely delivery, greater flexibility etc. All these demands connect us directly with the demands and the emphasis is on achieving the aim during the innovation process. Therefore, the demands for better quality, will initiate the creation of innovation process in the manufacturing area, which in turn can lead to implementation of new technology and innovation in technology in order to fulfil the target.

Competition pressure is very useful for many innovation companies and refers to the market coverage, our community and its influence. Competition can help us address the business' weaknesses through: insufficient market coverage, poor marketing, decrease in sales, more expensive products/services, less quality etc. Of course, we will also refer to something which was previously mentioned, asking questions of the competition during a period of time, which helps in following them but also being different.

For example, poor marketing will initiate changes in the same area and with proper marketing strategies, i.e. innovation processes we will focus towards maintaining competitiveness.

It's also worth pointing out that, innovation cannot be limited to only one business' area, the process itself involves changes in the organization as a whole, which again underlines the importance of cooperation and information flow.

Self-initiative for innovation and growth refers to the search and identification of opportunities and comprises all previously mentioned factors. In this case, the definition of the aim, which triggers the innovation process, is completely under our command and we pose the directions for improvement ourselves.

Building a working environment where self-initiative is the main driver of the business is something we all should aspire to because that enables us consistent growth and value creation.

Managing the innovation process

Innovation management clarifies, i.e. defines the decisions, activities and practices that drive the idea towards realization, in order to generate business value. Identification and success in implementation of the innovation and the repeatability and continuity of themselves, is a key objective of innovation management.

Regardless of which innovative paradigms, i.e. models will adapt and use, there will be concrete performance indicators (KPI – Key Performance Indicators), which can be developed by formalization of specific innovation process.

Innovation is fairly complex concept composed of several steps and always occurs in a context. Some of the factors in this context may be helpful / useful to us, and some harmful. Visualization and connections of useful and harmful factors in an innovative process and achieving sustainable improvement are presented in Figure 2.

Effective innovation recognize the benefit and harm in every situation, barriers and constraints, previous (past) successes, the enablers and resources, available for guidance, i.e. driving improvement and managing each of them respectively.

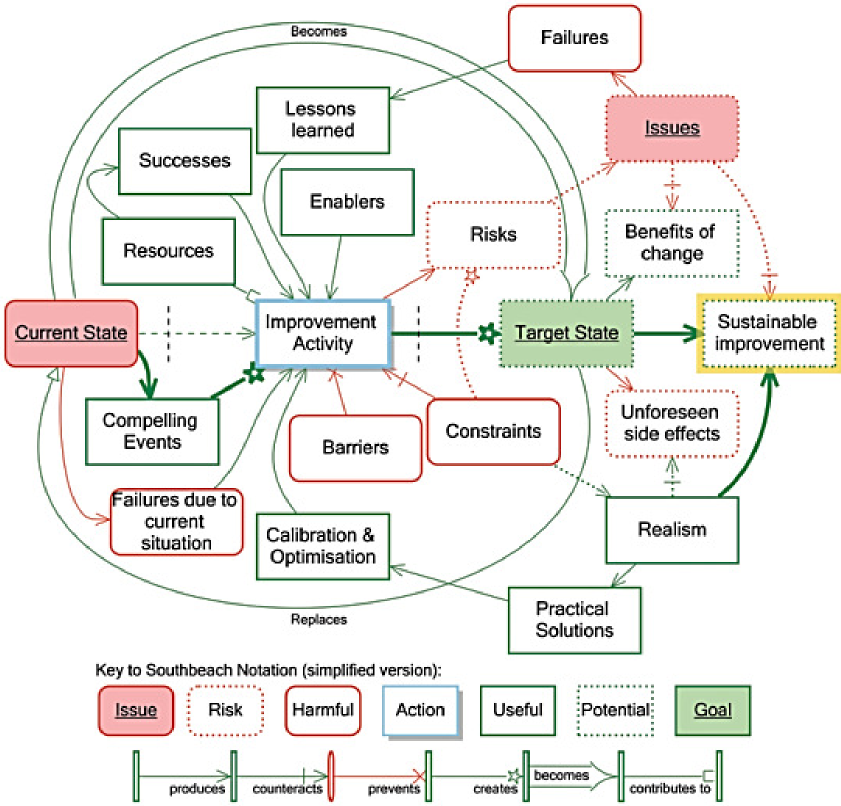

Fig. 2. Innovation improvement process [2]

The visual model, presented in Figure 2 is an example of a formal method for innovation. Such methods can be used to structure the creativity and innovative analysis of resources and opportunities, in attempts to reduce risk and increase confidence in innovative approach. Each symbol and color has its own meaning.

As shown, the ***current state*** is harmful (risky, unstable), but not sufficiently harmful to cause any ***improvement activity.*** This improvement activity is actually created by some initiative (stimulating, causative) event, which is a result of harmful situation. Stimulative event is inevitably harmful, but actually, here we consider it to be useful, because initiate activities and changes for improvement. Improvement activities however, create ***target state***, which is useful and results in ***sustainable improvement*** as much as the innovation is realistic and viable in itself.

Key performance indicators

First of all, we should mention that all KPI (Key Performance Indicators) are indicators that needs to be combined with specific, i.e. concrete facts that could be helpful in making concrete business decisions, in terms of improvement and development.

Innovation is all too often about balancing tensions and ensuring conversion of ideas or investment or sales leads into tangible value. Many of the KPIs below are expressed as ratios, for example: the ratio of ***new product revenue : old product revenue,*** provides a measure of the pace of innovation; if this ratio decreases, it indicates that innovation is falling behind obsolescence, so costs could increase and new revenue decrease [2].

Conversion ratios for each step in the innovation process / value stream [2]

- Ideas : Ideation campaigns
- Ideas that reach concept design : Ideas
- Implemented designs : Concept designs
- Ideas that sell : Implemented ideas
- Ideas that make a profit : Ideas that sell
- Sales : Target customer base

Financial & market measures [2]

- Revenue from new products or services
- Profit from new products or services

- New customers from new products or services
- New segments and sector entry from new products and services

Holistic ratios for the rate of renewal of the organization [2]

- Sales from new products & services : sales from existing products & services
- Profit from new products & services : profit from existing products & services
- Customers on the new products : customers on the old products
- Rate of transfer of capital investment to new capabilities

Balancing the desire to innovate with risk management [2]

- Verified knowledge : Unverified assumptions
- Effort spent on implementations : Effort spent on concept development

Innovation competency / Effectiveness / discipline / Repeatability [2]

- Use of formal creativity tools & techniques
- Use of formal idea management tools & techniques
- Use of formal problem solving tools & techniques

Growth and sustainability measures [2]

- Revenue from new products & services; Profit from new products & services
- How much have your customers increased their success (quality/sales/revenue/…) or reduced their cost due to use of your products and services
- Rate of return on innovation investment (how sustainable is your innovation)
- Market share growth from new products & services
- Brand awareness and stickiness (those who stay on new product : those who leave)
- Patents created per year : Marketshare protected by patents
- Revenue protected by patents : Revenue generated from lisencing patents

Everyone has a different view of what Innovation is – and how to best innovate to improve company performance, or better help clients. Setting clear KPIs are a way for the leadership team to get everyone pulling in the same direction – both in terms of what they are trying to achieve, and how they are trying to achieve it. More sales can be achieved by reducing price, increasing quality, improving brand awareness, creating "product stickiness" and a thousand other ways… but typically you need a focused strategy to succeed and avoid confusion amongst your staff and your customers [2].

The important thing to be known is that innovation involve risk, to the same extent as their potential. Therefore, there must be included a moderate control. Innovation has to be practical and to balance the approach to themselfs.

Thus, we can freely say that innovation management quickly became a major factor in ensuring sustainable business.

Some of the main advantages with the proper functioning of it self includes:

- Improvement of the timeframe for market introduction;
- Ability to maintain or improve business margins;
- Provides access to new customers and markets;
- Increased market share;
- Improved and long-lasting competitive advantage;
- Increased engagement and initiative of employees;
- Increased satisfaction among consumers;
- Sustainable increase in shareholder return on investment.

Decision making framework (structure / model) ensures the complete innovation environment, aided by an innovation management. Thus, simultaneously identifies the type of innovation, along with the context of evaluation, potential value and necessary influence and scope, for providing efficient investment choice

EXAMPLE FOR PRACTICAL APPLICATION OF INNOVATION MODEL

For convenience, the application and the importance of implementation of the innovative model in the everyday functioning of a company, which is striving for growth and development, we will present a case study, most appropriate to respond to the main features required of it and provide support into the implementation of innovative processes and their proper management.

First of all, we should mention that it is about a company engaged in the production of confectionery products, better said, acts in the sector of the food industry, but for the protection of personal details, we will refer to it as company "X" which belongs to the group of medium-sized enterprises with 55 employees and even more specifically, it's a company which is producing marmalade and jam for retail.

It has one production line, warehouse, laboratory for development, distribution channels as well as commercial and marketing as key sectors in the enterprise. The team, formed to research, seeking opportunities and implementation of innovative processes, is composed of representatives from all the sectors of the company, with appointed team leader.

The example shows the development of a new product which is already implemented in the company, but we will reformulate it as well as the process of adding value through innovation activities, presenting an innovative model, which actually sums up the theoretical and conceptual approach given in the past presentation.

The team, formed to provide and implement innovative activities in the company, aims, or stands for innovative process, looking for opportunities that will increase market coverage and meet the demands and needs of consumers, ensuring a competitive and total asset growth of the company.

Innovative activities will be guided by the "Stage-Gate" model, but it will be further modified and supplemented by adding the main principles of theoretical systematization, creating an innovative business environment.

The visual representation, of the model through which will guide to the most adequate management and making the right decisions, risk reduction and safer drive towards innovative value is given in Figure 3 and shall explicate.

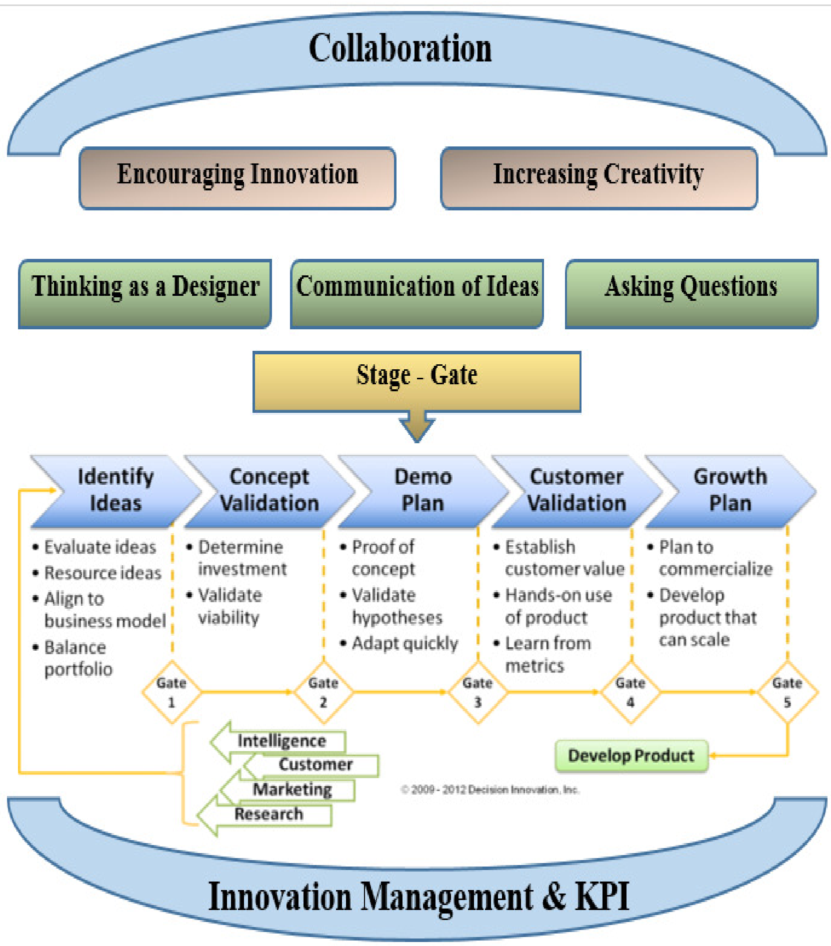

Fig. 3. A complete innovative conceptual model

As presented, Figure 3, innovative directions of functioning, first of all, has to be supported by a high level of ***collaboration***, internally and externally. Collaboration itself, in an interdependent relationship with other key factors in the innovative strategy, complements the inevitable aspects of successful innovation. Therefore, innovation team, of company "X", at first, have the task to undertake the following activities, ie ***encouraging innovation and increase creativity***. In that context the innovation team of company "X", is directed towards the design thinking, ie monitoring of customers (existing and potential) in several aspects, detecting the real problems, frequent "brainstorming" meetings etc. All these activities lead up to generating of a multitude of ideas, which are still just the product of human intuition, those ideas has to be adequately communicated. This ***communication of ideas***, by the innovation team of the company "X" are performed internally within the company and externally. Communication is mutual with clear and specific feedback information and carried out by competent persons, internally and externally.

In accordance with the goals of the company, the team uses its excellent collaborative relations for ***asking questions***. Questions for the customers (current and target), for the community and for competitors (current and potential).

All these interdependent factors in order to provide the basis for implementation of innovation process, additionally supported with freedom of expression, lays the foundations upon which the company "X" will move far more secure and stability towards "Stage-Gate" innovation model.

Stage 1: Identify ideas

High levels of collaboration, the design- thinking, the communication of ideas, the questions asked by the innovation team of the company "X", and the multitude of "brainstorming" meetings, in a context of the objectives, with special focus on meeting the demands and needs of consumers, have exposed the following ideas:

- Expansion of current production line in order to increase production of the current range;
- Expansion of the product line and production of related products;
- Technical modernization of machinery;
- Modification of packaging;
- Completly new products;
- Modification of current products;
- Increasing marketing investments;
- New production line for producing fruit juices;
- Staff training;
- Product patenting;
- Product branding.

According to the presented ideas and great communication of the same, with all those involved and the community, as well as market research, it's made the most appropriate evaluation of them. As we have already indicated, innovation activities, undertaken by the team of the company "X", will be driven by market demand and needs. It leads to the reduction, ie refining of the enclosed ideas and taking into account those that have the highest demand and mostly fits to the business model of the company.

Market research and uninterrupted communication and connection with consumers suggest specific demands in terms of the production of marmalade. This first of all refers to the specific application of marmalade or deficient market opportunities for modified features of marmalade and its use as raw material in other end products.

Gate 1: In this context, a team leader, in cooperation with other team members, evaluate the following ideas:

- Modification of the current products;
- New production line;
- New package.

Stage 2: Concept validation

Research of the market, competitors and consumers, in terms of ideas for modification of current product, a new production line and new packaging, in accordance with demand and required investment demonstrate exceptional differences in the financial portfolio.

That means additional investments in the construction and implementation of a new production line or additional investments in special new packaging machine.

Under its current capacity of the company "X", the financial viability of the ideas will define the ***modifications of the current product*** as the main innovative activity, building a business plan based on past experience, which will enable production of marmalade with special features, used as raw material in another end product.

Gate 2: The team leader, in accordance with the other team members of the company "X", gives an affirmative answer for continuation of innovation process, aimed at producing marmalade with special features and appropriate needs, i.e. application.

Stage 3: **Demo plan**

In conformity with our research and professional expertise of the innovation team, a business plan for producing marmalade as raw material, is appropriately adapted according to the capacity of the company and existing product lines. The product which would be implemented in the production line, for testing the same with consumers, requires a modification of the characteristics of existing marmalade in producing of the company "X". In cooperation with target market/customers, the innovation team, decides to adjust the production of raw marmalade for a croissant and marmalade as raw material for a biscuit cake on the existing production line.

Development of a new product according to the requirements and market needs, is based on the differences in the structure of its, or more precisely, marmalade for croissant and biscuit cake is quite stable, comparing to the current marmalade that is produced for retailing in markets. This means that technologist, who is part of the innovation team of the company "X", in collaboration with other members should come up with a solution to additional features of raw marmalade that will not allow rapid waste of the end product.

Therefore, according to the requirements and market needs and deficiency (which occurs as opportunity) of marmalade as raw material in another final product, is implemented in production. Current production capacities allows certain additional working hours on production line, which will be fulfilled for creating prototype of the new product.

Gate 3: Once all conditions are provided, the team leader allows production of marmalade as raw material, with special features, for presentation and testing with targeted consumers.

Stage 4: **Customer validation**

Once the new product is tested by targeted market, the next step is research, in terms of acceptability by customers. These collaborative relations and the research itself as a feedback provides specific requests from the customers, according to the product features, respectively:

❖ Demand of marmalade as raw material in end product croissant, which has the following characteristics:
- Durability in croissant of 9 months minimum;
- To be able to inject into croissant with a syringe;
- The percentage of fruit to be of 30 – 40%;
- Target price to be less than 2 euros per kg;
- To be shipped in large quantities (> 200 kg).

❖ Demand of marmalade as raw material in end product biscuit cake, which has the following characteristics:
- Durability in the end product of 12 months minimum;
- To be liquid enough, so you can rub it on easily;
- The percentage of fruit to be of 40 – 50%;
- Target price to be less than 2.5 euros per kg;
- To be shipped in 10 kg packaging.

Gate 4: Due to the similarity of the products, the team leader, in collaboration with other members, and above all, with technologist, responsible for development and modification of new products, makes a decision for production of both types of marmalade.

Stage 5: **Growth plan**

A plan for commercialization of marmalade, as raw material for croissant and biscuit cake, according to attached demands and research of the market and consumers as well as quantitative demand, leads to further discussions of innovation team and revisions of current opportunities in terms of capacity. That in turn leads to further research and activities, for eventually to come to decision that it should be extended the current production line, by buying and installation of a new machine for production.

The financial portfolio, which is well handled, allows such an investment and business plan for commercialization and growth, projecting return on investment in the second quarter of the work.

Gate 5: Newly developed products, or modification of existing marmalade for a retail sale in markets, to marmalade as a raw material for croissant and biscuit cake does not disrupt the current market on which we act and operate, but instead allows capture of larger market, and thus entail increased productivity of the operation and better performance of the investment portfolio.

This innovative process is mostly based on maintaining and refining through the "Stage-Gate" model complemented with management portfolio at the level of each stage. The answer to whether well-managed the innovation process is, we receive it at each gate.

Key performance indicators in turn, derived from relations, which in the present instance are mostly related to:

Financial & market measures

- Revenue from new products or services;
- Profit from new products or services;
- New customers from new products or services;
- New segments and sector entry from new products and services.

Holistic ratios for the rate of renewal of the organization

- Sales from new products & services : sales from existing products & services;
- Profit from new products & services : profit from existing products & services;
- Customers on the new products : customers on the old products;
- Rate of transfer of capital investment to new capabilities.

Growth and sustainability measures

- Revenue from new products & services; Profit from new products & services[
- How much have your customers increased their success (quality/sales/revenue/…) or reduced their cost due to use of your products and services;
- Rate of return on innovation investment (how sustainable is your innovation);
- Market share growth from new products & services.

CONCLUSION

Innovations and their implementation in a modern business environment, in order to provide a competitive advantage, development and maintenance market is extremely important for any company. Studies, which are specifically targeted towards innovative activities of Macedonian companies, pointed to problems in terms of running through these processes. In this context, building a successful innovative organization requires creating a kind of innovative structure, i.e. framework or model. Building this model consists of several basic principles in providing a business environment conducive for a smooth and most appropriate implementation of innovation in companies. These principles are guided by several key elements, i.e. perceiving and self-awareness of the meaning and importance of innovation, increased levels of collaboration and creativity, which on the other side, will naturally encourage innovation, generating ideas with the greatest potential and appropriate guidance through the process by managing decisions and measuring performance.

The most appropriate model that fits every organization, regardless of the industry in which they operates, providing specific advantages in terms of its practicality and support of innovative processes, is the "Stage-Gate" model.

This model provides key attributes for understanding, monitoring and acting in an innovative working environment, which are: simplicity, descriptiveness, measurability, predictability and timeliness. It certainly needs to be properly managed, and it is subject for extracurricular activities, which are provided with systematized approach to create proper conditions for innovative aspirations.

However, we should mantion that innovative processes are the fruit of creative ideas and thoughts and can’t be completely managed by strict rules and regulations. For adequate decision-making, with particular emphasis on increasing collaboration within the organization, this conceptual innovative framework is a huge benefit, providing support for companies and a roadmap for successfully creating innovative value and business development.

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Original scientific paper

HUMAN MACHINE INTERFACE OF THE CONVENCIONAL AND ELECTRIC VEHICLES – A COMPARATIVE STUDY

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A b s t r a c t: The launch of electric vehicles and ITS initiated new challenges for design related ergonomics in the vehicles, especially in the field of Human Machine Interface (HMI). This research is motivated by the necessity for evaluation of current ergonomic and design solutions of contemporary vehicles powered by internal combustion engine, from one side, and electric vehicles, on the other side. The presented study included a review of available literature and regulations, state of the art, as well as operational analysis based on detailed comparison between vehicles. An assessment has been done between two existing vehicles of the same model, the first one powered by the internal combustion engine, and the other one powered by an electric engine. The information displays, vehicle controls and secondary vehicle controls of both vehicles were carefully analyzed and compared. The results of the study are presented as a source of preliminary understanding of the newly developed technology for designers and other professionals.

Key words: electric vehicle; ergonomics; intelligent transport systems; human machine interface; vehicle design

ИНТЕРФЕЈС ПОМЕЃУ ЧОВЕКОТ И МАШИНАТА КАЈ КОНВЕНЦИОНАЛНИТЕ И ЕЛЕКТРИЧНИТЕ ВОЗИЛА – СПОРЕДБЕНА СТУДИЈА

А п с т р а к т: Воведувањето на електрични возила и на интелигентни транспортни системи (ИТС) предизвика нов пристап кон ергономијата поврзана со дизајнот на возилата, посебно во областа на интерфејсот помеѓу човекот и машината (HMI). Ова истражување е мотивирано од неопходноста да се оценат постојните ергономски и дизајнерски решенија на современите возила погонувани со мотор со внатрешно согорување, од една страна, и електричните возила, од друга страна. Студијата вклучува преглед на расположливата литература и прописите, состојбата во областа, како и оперативна анализа заснована на детална споредба помеѓу возилата. Извршена е споредбена процена на две постојни возила од ист модел, првото погонувано со мотор со внатрешно согорување, а второто погонувано со електромотор. Внимателно се анализирани и споредени информационите дисплеи, командите, како и секундарните команди на двете возила. Резултатите од студијата се презентирани како извор за почетно разбирање на новоразвиената техника од страна на дизајнерите и другите професионалци.

Клучни зборови: електрично возило; ергономија; интелигентни транспортни системи: интерфејс човек – машина: дизајн на возило

INTRODUCTION

The general development of technology has a very important impact in the world of vehicles design. The vehicles are products for everyday use, but for some people they are important equipment for their work. At the same time, they carry many risks and dangers which must be taken into serious consideration regarding the safety. One of the aspects critically related to the safety is the ergonomics. Ergonomics is associated with the technology development, so the designers of vehicles are meeting new challenges to fit their solutions compromising the safety aspect. Cock-pit design, and other interior design elements have well-known relation with automotive safety, both active and passive. Ergonomic aspects of the design have a complex influence on the automotive safety, and innovative solutions are always welcomed. On the other hand, innovations may create a chance for improvement of the ergonomic design which should be recognized and employed by designers.

Two areas of the vehicles development are distinguished by their multi-disciplinarity and innovation – the application of intelligent transport systems (ITS) and the rising development of electric vehicles (EV). There are a number of authors already tackling these issues. On the other hand, the number of vehicles with advanced ITS components, and electric vehicles in use, is still very low which limits the amount of experiences how successful designers have been in this regard. It is yet to be found out how customers perceive these problems. One of the pragmatic approaches a designer could choose is taking the best of the previous solutions and creating even better implementing innovative technology and bringing the vehicle into new, more advanced state.

Deur, Škugor and Cipek declare that the problems of optimal EV architecture design and control and EV optimal charging are strongly dependent on the driving cycle characteristics of a target EV fleet [2].

Some ergonomic problems are typical only for the electric vehicles. One of them is the lack of engine sound which could be dangerous for the pedestrians. The results of the research of Bolkovac, Horvat and Jambrošić present the evident differences in acceptability of different IC engine sounds which could be potentially used as artificial warning sounds for hybrid and electric vehicles [1].

Our team has experience with ergonomic researches concerning the seating comfort in the driver's seat for passenger vehicles. The comfort seating postures of the driver were analyzed with application of virtual mannequins considering the comfort angles for the placement of human body and the necessary space for foot controls in vehicles, as well as the ranges of adjustments of the driver's seat and steering wheel [8].

This paper will briefly present an explanation of the techniques and terminologies used in the areas of intelligent transport systems and electric vehicles, and will try to give an initial assessments about the aspect of the design related to the driver activities, which means ergonomics and safety. A chapter of this paper will be dedicated to direct comparative analysis of the mentioned aspects, a comparison between two existing vehicles of the same model, the first one powered by an engine with internal combustion, and the other one powered by an electric engine.

BASICS OF ITS, ELECTRIC AND HYBRID VEHICLES

Development and innovations in the field of vehicles design partially refer to introduction of electric vehicles and ITS components. As a result, there are a number of specific features from the aspects of design and ergonomics. In continuation of this section, short terminology and basic technical information related to the innovations mentioned will be given.

There are main concerns that are constantly related to vehicles and transport systems including emissions, potential crash injuries, severe traffic congestion, etc. Intelligent transport systems (ITS), responsible for dealing with these issues and with the technologies behind them, are offering an optimistic view on the future of the vehicles. Therefore, it is expected that the improvement and implementation of the intelligent transport systems (ITS) in the vehicles and transportation infrastructure will contribute in fighting the issues mentioned [3].

A. ***Intelligent Transport Systems ITS***

Intelligent Transport Systems ITS technology allows connection and communication between vehicles, as well as between vehicles and road infrastructure. ITS covers a wide range of systems with a purpose to improve the complete picture of a safe, fluent and energy efficient road transportation. Starting from the car manufacturers implementing the new technology because of the expected wide application, interests in the development benefits caught the attention of the policy makers as well. The future of mobility is likely to be significantly changed looking at the wide range of technologies offered, starting from information of the current traffic state, collision avoidance systems, automatic emergency calls, etc. [5].

One of the most important impacts that goes alongside the intelligent transport systems is, of course, the drivers' behavior. Optimizing and increasing the information that the driver gets as a feedback from the vehicle is crucial. The ergonomics and design of the vehicle have to offer clear and easy-to-understand information to the driver, and, at the same time, to avoid creating a distraction. Therefore, gathering information on the impact of the drivers' behavior to the intelligent transport systems is crucial [3].

Falko Dressler and Christoph Sommer [4] investigated the impact of human driver behavior on the quality of ITS. Their solution, which has been integrated into the publicly available Veins framework, allows to run integrated simulation experiments taking the driver's behavior into account. They suggest that simple probabilistic models can be used to represent complex empirically generated models.

B. *Electric and hybrid vehicles*

It is very difficult to make difference by their external appearance between the vehicles with internal combustion engine (ICE powered vehicles), on the one hand, and the electric and hybrid vehicles, on the other hand. Anyhow, the electric and hybrid vehicles have already placed a significant mark in the world of the vehicles. Even with a perception of their motion it is hard to notice any difference between ICE powered vehicles and electric and hybrid powered vehicles. The difference is, however, in the power-train, which is out of the eye reach of the vehicle users (Figure 1).

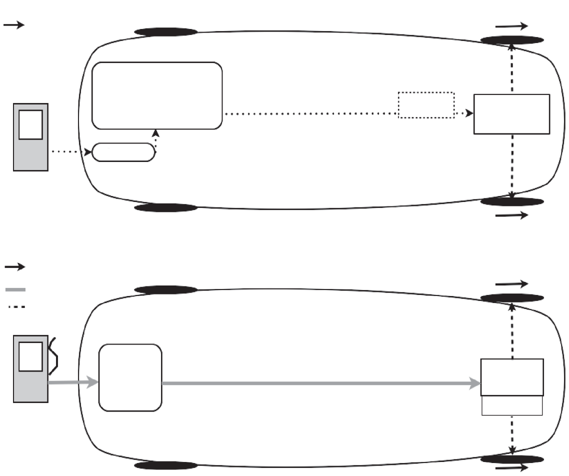


Fig. 1 Fundamental differences between an internal combustion engine (ICE) vehicle and an electric vehicle (EV)

VEHICLES ERGONOMICS IN THE CONTEXT OF DEVELOPMENT OF ITS AND ELECTRIC VEHICLES

In the last 20 years, the automotive industry experienced a massive expansion in the applied technology. From the electronics used in vehicles to the development of completely new systems, these rapid changes have created new challenges for automotive ergonomics as well. Modern technologies surround the driver in the vehicles today, starting from mobile phones, navigation, entertainment systems, etc., which pose risks of serious distractions, hence, significantly lowering the driver's attention. Undoubtedly, one of the main research challenges in the ergonomics is the visibility and drivers perception, studies of the visual attention and possible distractions.

Electric vehicles disclose a lot of new aspects related to the driver habits as well. Nevertheless, as much as the electric and ICE powered vehicles may seem alike from the outside, there are numerous differences in controls and cock-pit instruments which inevitably need to be designed in an ergonomic way.

A. *Identification of the ITS elements with an ergonomic significance*

Globally, the most widespread form of transport is not immune to the technologies that became a part of everyday life. Mobile phones, as the most used devices for communication, are commonly used while driving.

From automotive ergonomics point of view the in-vehicle information systems (IVIS) made a great progress by offering to the driver an access to the features such as navigation, voice control, Bluetooth, touch displays, etc., which satisfy many of the driver's needs, but, on the other hand, they entail a number of challenges and risks.

After the antilock braking system made an entrance in the active safety systems, vehicle ergonomics provided more attention to the technologies that work in preventing an accident. With introduction of the technology named advanced driver assistance systems (ADAS) it ultimately became an active safety system itself, creating completely improved driving experience. ADAS is designed to help drivers to avoid distractions by non-driving related activities, but it could also contribute to averting other kinds of distraction. ADAS is an indication that the idea of fully autonomous vehicle is not far away.

B. *Identification of the elements of electric vehicles with an ergonomic significance – Human-Machine Interaction –*

With the introduction of electric vehicles many challenges have emerged. Looking from the general view of ICE vehicle users the apparent "range-anxiety" was just one of the questions and worries that came along. With the rapid developing automotive industry most of the worries that were existent were put to bed early.

At-home charging being the only first option for electric vehicles was quickly accompanied by fast-charging infrastructures. Wireless charging and even more advanced batteries were implemented in the newer electric vehicles. However, the acceptance that comes from potential buyers of electric vehicles just starts here.

The necessity of "familiarity" while driving such a vehicle is also present. Therefore, the driver-vehicle interaction is as crucial here as with every other vehicle. Judging by their external look it is hard to tell the difference from ICE vehicles, and at the same time, the approaching interior of the EVs looks equally as well. When entering an electric vehicle, setting up the driver's sitting position, adjusting the steering wheel high, are just few of the procedures that are the same as the ones in any modern ICE vehicle.

Users of ICEs vehicles with automatic transmission will find the EVs more familiar than users who drove only ICEs with manual transmission.

A number of authors deal with Human-Machine Interaction of electric vehicles [4]. According to the approach proposed by Allen, et al. (1971) [6] – the driving task has been considered on three levels:

Maneuvering (basic control tasks): steering inputs, gear shifting, operating the wipers and similar controls including managing lead headway in traffic.

Tactical level (tasks that require some conscious decision making, often in response to the changing traffic environment): deciding which route to take, taking a shortcut or not, adapting speed when weather driving conditions change.

Strategic level (highly demanding cognitive tasks, learned behaviors, attitudes, and even beliefs that precipitate the relationship with the vehicle, other road users and the road environment): problem-solving mechanisms of plotting a route in a totally unfamiliar area, general attitudes towards speeding and risk taking, vehicle preferences, driving style and preferences, presumptions about other drivers, riders and pedestrians, and so forth.

Keeping the same three levels approach, it is noticeable that driver has to deal with changed HMI in electric vehicles. These changes are mostly related to the following aspects: information display, vehicle control and secondary controls (HVAC, wipers, charging control) [4].

Information display

Beyond the basic maneuvering level, information plays an important role to the tactical and the strategic level of driving (Michon, 1993) [4]. Electric vehicles are known as environment friendly, but the energy consumption information for the driver is of a top priority to be sure he or she will reach the destination. This information is both on the strategic and tactical level. More and more modern vehicles have need to include energy demand prediction and charging facilities, as well as quickest and shortest routes. Therefore, many electric vehicles have included energy consumption information, often combined with eco-driving advice.

The type and contents of information normally are: estimated range and charging points, both visualized on the area map, instant flow of energy, battery information, and some form of longitudinal efficiency feedback based on the trip distance already covered [7].

Vehicle control

Vehicle control consists of longitudinal and lateral control.

Longitudinal control is realized through the operation of pedals and the gear level. While lateral control which is realized by the operation of the steering wheel is the same in EVs and ICE powered vehicles, things change for the longitudinal control.

Due to different characteristics of electric motor which can start under load, EVs do not need clutch control. Instead of a gear selector, EVs require a simple drive selector for the forward, backward and parking position. Additional driving modes such as ‘eco’ may be included.

Secondary controls
(HVAC, wipers, charging control)

Most of the secondary controls of the EVs are very similar or equal to those in the ICE powered vehicles: control of heating, ventilation and air-conditioning (HVAC), wipers control, and, in the case of EVs, charging control.

Control of heating, ventilation and air-conditioning (HVAC) in the electric vehicles is very much related to the total energy spending and therefore to the vehicle efficiency, which is related to the vehicle range.

Charging of electric vehicles, even with application of quick-charging equipment is incomeparably longer than the filling of fuel of ICE powered vehicles. That empowers the need of management of the charging process and it’s planning, which puts additional tasks on the driver on tactical and strategic level. This is a very important difference between ICE and electric vehicles.

COMPARATIVE ANALYSIS OF HUMAN-MACHINE INTERFACE (HMI) ENVIRONMENT BETWEEN ICE AND EV VERSIONS OF THE SAME MODEL OF A VEHICLE

A. *Approach and operational activities*

The general perception from the outside of the ICE and EV versions of Volkswagen UP confirms the already known fact that they are not different (Figures 2 and 3). The only noticeable external detail is the different appearance in the charging socket of the EV, instead of the filling neck in the ICE vehicle (Figure 4).

For the people capable of noticing that difference, and having basic knowledge about vehicles, the mentioned external difference will lead to a conclusion that the two vehicles have big difference in terms of the power unit. Although having electric engine instead of ICE is seen as the biggest difference it is certainly not the only difference. The Human-Machine Interface (HMI) of the EVs differs to some degree from ICEs as well. This chapter of our research is dedicated to an analysis that has been made as a comparison between Human-Machine Interface (HMI) of ICE and EV versions of Volkswagen Up. The analysis is based on the operative review of both versions of Volkswagen Up (ICE and EV). All important aspects of the Human-Machine Interface (HMI) are checked on the vehicles and photos have been taken. In addition, appropriate owner manuals have been studied and interviews with sales persons and owners have been done.

Fig. 2. External appearance of ICEV

Fig. 3. External appearance of EV

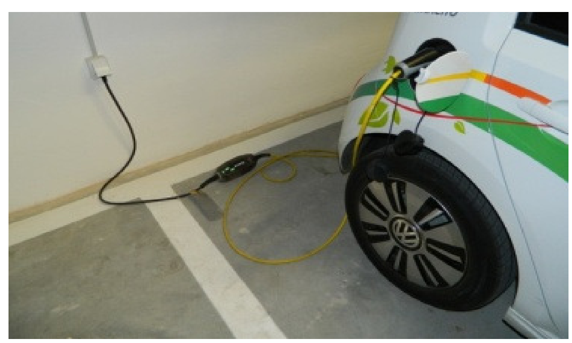


Fig. 4. Charging socket at EV

Table 1 shows parallel photos of information display, vehicle control and secondary controls for both vehicles. The table also contains comments for each important part of Human-Machine Interface (HMI).

Table 1

Comparison of the controls of the both versions of Volkswagen Up

Information display

Volkswagen Up – ICE version	*Volkswagen Up – E version*
	

Combined display

The display is generally with the same configuration.

Speedometer in the EV version with lower maximum speed (160 km/h vs 220 km/h)

The tachometer on the ICE version (left smaller cycle indicator) is replaced by power indicator on the electric vehicle

Fuel level indicator on the ICE version (smaller right cycle indicator) is replaced by indicator of battery level.

Vehicle control

Volkswagen Up –- ICE version	*Volkswagen Up – E version*
	

Steering control

No significant differences.

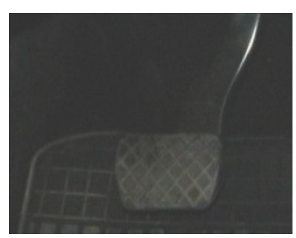
	

Gear control

Both vehicles have gear control lever.

The ICE version has standard 5 gear manual transmission control lever.

The EV version has "gear control" lever looking like an automatic transmission at ICE vehicles. The selectable positions are P – Parking, R – reverse, N – neutral, D – drive, B – braking which differs from the positions automatic gear lever ICE vehicles has

Foot control

The ICE model has a standard configuration for manual transmission (clutch, brake and acceleration pedal)

The EV model doesn't have clutch pedal and has a wider brake pedal, as well as an acceleration pedal which makes the configuration the same as the one used in ICE vehicle models with automatic transmission

Vehicle Secondary Controls
(HVAC, Directional Lights, Wipers)

Control of heating, ventilation and air-conditioning (HVAC)

Comment: HVAC (Heating, Ventilation, Air Conditioning) controls take the central place on the console in both models
The ICE model has a manual classical HVAC controls
The EV model has HVAC control with a digital display
The audio system controls are the same in both models

Directional lights control

Comment: The directional light controls are the same in both models

Wipers control

Comment: The wiper control is the same in both models

Lights control

Comment: The light controls are the same in both models

B. *Analysis of findings*

Based on the approach described above and on the content of Table 1, a comparative analysis of Human-Machine Interface between ICE and EV versions of the same model of vehicle was done. The analysis was divided on maneuvering, tactical and strategic level.

Maneuvering level

Steering input is performed via the same kind of interface – steering wheel. This activity does not differ between the analyzed vehicles.

ICE vehicle possesses a classical manual gearbox, which means the driver controls the clutch by a clutch pedal and the gearbox by a gear lever.

Electric vehicle does not have a clutch, therefore, the clutch pedal is missing. Regardless, the gear lever looks like the lever of in the ICE vehicle with automatic transmission, its function differs and that can be seen by the marks on the lever. This is very much related to the technical solutions in the electric vehicles and the driver needs to understand these differences and to be trained how to handle that lever. It is necessary in order to avoid improper use of the gear lever and potential distraction of the driver, or even worse, unwanted behavior of the vehicle in traffic. Acceleration pedal is on the same place in both vehicles and its use is the same. But, the driver of the EV should be trained to use the power indicator instead of the tachometer in the ICE vehicle. This is very much related to the energy consumption and since there is no engine noise, in this case, which most of the drivers are used to, there is a need of a building feeling on the driver's side to avoid too-often watching the indicator and the enormous power consumption. Other controls on this level, like those for direction indicators and wipers, are the same in both vehicles.

Tactical level

On this level the driver takes some decisions, like deciding which route to take to the wanted destination, adapting the speed when the conditions change or making other decisions related to the changing of traffic environment. Driving an electric vehicle means that the driver should be aware of the influence of external temperature to the batteries, the electric engine and other electric systems, occasional higher quantities of water on the road and so on. The analyzed electric vehicle does not possess additional indicators which would assist the driver in taking such decisions. Therefore, there is a necessity of such information which is normally available in user manuals. Changing the route to the final destination with electric vehicles, due to the limited possibilities of the charging, could sometimes lead to the powerless status, for example – in the case of traffic congestion in the changed route.

HVAC controls in EV allow the driver to input desired internal temperature. Since this is very much related to the energy consumption, and therefore to the vehicle range, there is a need for the driver to take correct decisions when input the commands on HVAC controls.

Charging is a new specific of electric vehicles which does not exist in the ICE vehicles. It includes several aspects, all related to this level. Those are – planning time and place of charging. There is one more task for the driver compared to ICE vehicles – to monitor battery level and to decide when to cancel the charging.

Strategic level

In this most complex level the driver takes high demanding cognitive tasks, like plotting the route in a totally unfamiliar area, the driving style and preferences, the risk-taking (for instance during overtaking) and so on. The electric vehicle analyzed has no interface which could assist the driver in relation to the activities in this level. There are no such interfaces in the ICE vehicle as well. But, most of the drivers are familiar with ICE vehicles and are capable of estimating the new vehicles performances based on the previous experiences. That is not a case with the electric vehicles and the drivers should be very much aware that the electric vehicles have different performances compared to the similar ICE vehicles. Without this awareness drivers could take wrong decisions, which, having in mind the importance of this level, could lead to potentially dangerous traffic situations. Also, bad decisions of the driver could lead to empty batteries where there is no possibility of recharging.

HVAC has the similar influence on this level as on the tactical level. So, the same remarks are valid on this level, as well.

Charging of the vehicle is also related to this level. All aspects mentioned in tactical level have the same importance on this level too.

CONCLUSIONS

Based on the activities and analysis described in this paper, few conclusions can be drawn.

The development of the electric vehicles is in a phase in which there is a need of complex approach towards instructing the drivers and other users how to take all the advantages they offer and avoid potential weaknesses.

The ergonomic aspects of the electric vehicles design can be studied through human-machine interfaces. Such study should consider all three levels of the driver's activities on the maneuvering, tactical and strategic level.

The results of the analysis presented in this paper show that, besides the fact that it belongs to a lower class of vehicles the electric version of Volkswagen Up has an influence on all three levels of driver activities. Due to the lack of experience of the drivers with electric vehicles there is an obvious need for them to be equipped with components of advanced driver assistant systems (ADAS) which could protect the driver from taking wrong decisions on each level. For the time being that is to be expected in high classes of conventional end electric vehicles and due to the price limitation that will not be a case in cheaper electric vehicles. Therefore, there is a need for a specific training of the new electric vehicle users.

Note: The paper is a part of the research for doctoral thesis of the first author.

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Professional paper

NEW EU TYPE-APPROVAL FRAMEWORK REGULATION FOR AGRICULTURAL AND FORESTRY VEHICLES

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A b s t r a c t: In the Official Journal of EU No. 167 from 2013 the new Regulation (EU) No 167/2013 of the European Parliament and of the Council of 5 February 2013 on the approval and market surveillance of agricultural and forestry vehicles has been published. This Regulation is a framework legislation that covers all technical requirements for agricultural and forestry vehicles before being put on the market. It will repeal the existing framework Directive 2003/37/EC and also 23 separate directives on 1 January 2016. The layout, the structure and main requirements are aligned with the framework legislation for motor vehicles with four or more wheels. The European Commission that prepared this regulation followed recommendations from the Competitive Automotive Regulatory System for the 21st century (CARS 21) report and therefore simplify the current whole vehicle type-approval regulatory framework. This Regulation is followed by seven delegated acts and one implementing act. This paper describes all chapters of this new regulation and point out all important and new prescriptions.

Key words: EU legislation; agricultural vehicles; forestry vehicles; approval

НОВА РАМКОВНА РЕГУЛАТИВА НА ЕУ ЗА ОДОБРУВАЊЕ НА ТИПОТ НА ЗЕМЈОДЕЛСКИ И ШУМСКИ ВОЗИЛА

А п с т р а к т: Во Службен весник на ЕУ бр. 167 од 2013 година е објавена новата Регулатива (ЕУ) бр. 167/2013 на Европскиот Парламент и на Советот од 5 февруари 2013, која се однесува на одобрувањето и на надзорот на пазарот на земјоделските и на шумските возила. Оваа регулатива е рамковна легислатива која ги покрива сите технички барања за земјоделските и шумските возила пред да бидат ставени на пазар. Таа ја заменува рамковната Директива 2003/37/ЕС, како и 23 посебни директиви, и се применува од 1 јануари 2016. Изгледот, структурата и главните барања се усогласени со рамковната легислатива за моторни возила со четири или повеќе тркала. Европската Комисија, која ја подготви оваа регулатива, ги следеше препораките од извештајот на Системот за регулирање на конкурентноста во автомобилноста за 21-от век (CARS 21) и на тој начин ја поедностави постојната вкупна регулативна рамка на одобрување на типот. Оваа регулатива е проследена со седум придружни акти и еден акт за имплементација. Овој труд ги опишува сите поглавија на оваа нова регулатива и ги нагласува сите важни и нови прописи.

Клучни зборови: ЕУ легислатива, земјоделски возила, шумски возила, одобрување

1. INTRODUCTION

On 2 March 2013 the new Regulation (EU) No 167/2013 of the European Parliament and of the Council of 5 February 2013 on the approval and market surveillance of agricultural and forestry vehicles was published [1]. This is the so called "mother regulation" that regulates all technical requirements for agricultural and forestry vehicles before putting on the market and is harmonized in all Member States of the European Union. The regulation entered into force the twentieth day after its publication, but it shall apply from 1 January 2016.

2. THE PREPARATORY WORK

Before this Regulation for the framework legislation the "Directive 2003/37/EC of the European Parliament and of the Council of 26 May 2003 on type-approval of agricultural or forestry tractors, their trailers and interchangeable towed machinery, together with their systems, components and separate technical units and repealing Directive 74/150/EEC" had been in use [2]. Because of this type of the legal act all Member States had to transpose it into their national legislation. In the Republic of Slovenia we transpose this Directive with the "Rules on approval of agricultural and forestry tractors" [3].

In the summer of 2010 the European Commission prepared the proposal of new framework legislation for the regulating the agricultural and forestry vehicles. For the legal instrument they used the Regulation instead of Directive. The background for this decision was a large impact assessment prepared in years 2008 and 2009 that resulted in a better way of organizing this area. The proposal has been prepared also in accordance with recommendations of "Competitive Automotive Regulatory System for the 21st century" (CARS 21) [4].

The goal of the new Regulation was to ensure in the field of agricultural and forestry vehicles the high level of traffic safety, work safety and environment protection. Based on these, they decided that technical requirements and environmental standards for approval of vehicles, their systems, components and separate technical units had to be harmonized.

The European Commission has justified this with reference to the impact assessment that showed that the present system in the field of agricultural and forestry vehicles is too complicated for vehicle producers and also for approval authorities. Furthermore they found out that all Member States have to transpose all directives into their national legislations, which creates a lot of additional work for them without added value. And, with this proposal they had an idea to improve the work of the internal market of the European Union in order to bring easier movement of agricultural and forestry vehicles between Member States.

The text of the Regulation has had to undergo the public consultation procedure and also a lot of consultations on various working sessions in the European Commission, European Council and European Parliament. Therefore the text has been changed during this procedure and the final compromise was reached at the end of year 2012.

3. WHAT IS NEW?

3.1. *In general*

The first thing is the new form of the legal act. This is a Regulation instead of Directive that means that there is no need to transpose it into the national legislation. The Regulation is in force in all Member States on the same day. That means that the National authorities have significantly less work than with Directives, there is no possibility for mistakes in transposing and also there is no need for the European Commission to check the proper transpositions in Member States.

Technically all requirements in the Regulation are on the same level as they are now.

The Regulation will be followed by some implementing and delegated acts that represent the new approach in the legislation, so called "split level approach". The number of these acts will be lower than at present. At the moment under the framework Directive there are 23 separate directives. It is foreseen that only 8 acts will follow this Regulation:

– delegated act on functional safety of vehicles,

– delegated act on occupational safety,

– delegated act on environmental performance,

– delegated act on braking,

– delegated act on testing,

– delegated act on access to repair and maintenance information,

– delegated act on technical services,

– implementing act on harmonized administrative requirements.

3.2. *An overview of the Regulation*

3.2.1. *Chapter I: Subject matter, scope and definitions*

There is a statement in the Article 1 that this Regulation establishes the administrative and technical requirements for the type-approval of all new vehicles, systems, components and separate technical units. However, this Regulation is not applicable for the approval of individual vehicles but, essentially, it determines the requirements on market surveillance of vehicles, systems, components and separate technical units and also of the equipment.

This Regulation is applicable on wheel tractors (category T), track-laying tractors (category C), trailers (category R) and interchangeable towed equipment (category S). It is not applicable on interchangeable machines that are fully raised from the ground or that cannot articulate around the vertical axis when the vehicle to which it is attached is in use on a road. The manufacturer may choose between procedures from this Regulation or national requirements for trailers, interchangeable towed equipment, track-laying tractors and for special purpose wheeled tractors (category T4.1 and T4.2).

The basic classification of agricultural and forestry vehicles is not changed. It consists of: tractors (category T for wheeled and C for track-laying tractors), trailers (category R) and interchangeable towed equipment (category S). There are changes in subcategories. For category T we have now subcategories T1, T2, T3, T4.1, T4.2 and T4.3 (the same at category C) with the index "a" if they have the maximum design speed below of equal to 40 km/h or "b" if they have the maximum design speed more than 40 km/h. This is the same categorization as was in use for trailers and interchangeable towed equipment.

3.2.2. *Chapter II: General obligations*

The Chapter II of this Regulation regulates the obligations of Member States regarding the designation of approval authorities and surveillance authorities as well as the method of market regulation, obligations of approval authorities and market surveillance measures. Market surveillance authorities will perform their tasks at manufacturers of agricultural and forestry vehicles and equipment, their representatives, importers and distributers. In articles that follow we could find obligations of manufacturers, representatives, importers and distributers especially for products that are not in conformity or that present a serious risk. For the last mentioned there are obligations for immediate actions concerning the corrective measures for withdraw or recall of such products from the market.

3.2.3. *Chapter III: Substantive requirements*

This Chapter is probably the most important part of this Regulation because it defines technical requirements for approval of agricultural and forestry vehicles. It was mentioned before that this requirements are on the same level as they are already now. These requirements are divided into:

Requirements for the functional safety of vehicles where we could find vehicle structure integrity, vehicle lighting systems, audiable warning devices, vehicle occupant protection, masses and dimensions, etc.

Requirements for occupational safety where we could find ROPS, FOPS, OPS, driving seat, safety belts, batteries, etc.

Requirements for environmental performance where we could find pollutant emissions and external sound level. For the limit values for pollutant emissions the regulations hawe the references to the Directive 97/68/EC that regulate the emissions from mobile machinery. In this article we could find limit values for external sound levels. There are only two limit values; that for tractors with an unladen mass in running order of more than 1500 kg (89 dB(A)) and for those that the mass is not more than 1500 kg (85 dB(A)).

3.2.4. *Chapter IV: EU type-approval procedures*

The Chapter IV of this Regulation gives to the manufacturer different procedures to obtain the whole vehicle type-approval for the agricultural and forestry vehicle they produce. The manufacturer has now possibility to choose step-by-step, single-step or mixed type-approval. Requirements regarding the documentation are very similar to recent requirements. The European Commission has to prepare templates for information documents by 31 December 2014.

3.2.5. *Chapter V: Conduct of EU type-approval procedures*

The content of this Chapter is very similar to the current situation laid down in the framework Directive. We find here the EU type-approval certificate, test requirements and provisions regarding the conformity of production. The European Commission has to prepare, firstly, implementing acts regarding the numbering of implementing acts, the content of EU type-approval certificates, the templates of test reports and the list of requirements of acts by 31 December 2014. By the same date the European Commission has to prepare also the first delegated acts concerning the detailed arrangements for the conformity of production.

3.2.6. *Chapter VI: Amendments to EU type-approval procedures*

Also the content of this Chapter is very similar to the content of recent framework Directive. It regulates revisions and extensions of EU type-approvals, issuing of amendments and notifying approval authorities in other Member States.

3.2.7. *Chapter VII: Validity of EU type-approval*

In this very short Chapter we can find in which situations the EU type-approvals become invalid. The content is very similar to the current.

3.2.8. *Chapter VIII: Certificate of conformity and markings*

This Chapter consists of the prescriptions regarding the vehicle certificate of conformity and on statutory plate that shall affix to each vehicle manufactured in conformity with the approved type. The content is also in this Chapter very similar to the current, but the European Commission has to prepare the first implementing acts regarding templates of Certificates of conformity by 31 December 2014.

3.2.9. *Chapter IX: Exemptions for new technologies or new concepts*

The content of this Chapter is completely new in this field and it regulates how to accept new technologies and the procedure to authorization by European Commission. For every new technology the authorization from European Commission has to be given by means of an implementing act. There is also an article that regulates the procedure for the European Commission to adapt delegated and implemented acts with new technologies.

3.2.10. *Chapter X: Vehicles produced in small series*

This Chapter regulates for the possibility of a manufacturer applying for the national type-approval of small series, but in number of vehicles prescribed in the Annex II of this Regulation. For the national approval authorities there is a possibility that could waive one or more of the provisions listed in Annex I could be waived if they have reasonable grounds but they have to specify the alternative requirements. The validity of this national type-approval is restricted to the territory of the Member State whose approval authority granted the approval. Approval authorities in other Member States could decide if they will accept such type-approval or not.

3.2.11. *Chapter XI: Making available on the market, registration or entry into service*

In this Chapter there are prescriptions separated in articles for vehicles build in large series, in small series and for components and separate technical units. All vehicles produced in large series have to be followed with the valid certificates of conformity. The number of vehicles produced in end-of-series shall not exceed 10% of the number of vehicles registered in the two preceding years or 20 vehicles per Member State, whichever is higher.

3.2.12. *Chapter XII: Safeguard clauses*

This Chapter prescribes a harmonized procedure for all Member States in how to handle vehicles, systems, components or separate technical units if they present a serious risk to the health or safety of persons or to other aspects of the protection of public interest. There are articles separated for vehicles, components and separate technical units. There is also an article that describes the recall procedure for vehicles, systems, components and separate technical units if they present a serious risk to safety, public health or environmental protection even if they are approved according to this Regulation. The recall procedure is in accordance with the Regulation (EC) No. 765/2008, that prescribes the requirements for the accreditation and market surveillance of these products.

3.2.13. *Chapter XIII: International regulations*

In this Chapter we could find stipulations about the recognition of UNECE Regulations that the European Commission perform with the acceptance of the relevant delegated act. The same procedure is also for acceptance of the OECD technical reports.

3.2.14. *Chapter XIV: Provision of technical information*

The Chapter XIV of this Regulation regulates the obligations of manufacturers to make available to users all relevant informations and necessary instructions any special conditions or restrictions linked to the use of a vehicle, system, component or a separate technical unit. It is also prescribed the exchange of information between the vehicle manufacturer and the manufacturer of components or separate technical units.

3.2.15. *Chapter XV: Access to repair and maintenance information*

With this Chapter the Regulation establishes the obligations of manufacturers providing all relevant informations for vehicle repair and maintenance to authorized dealers, repairers and independent operators. These prescriptions are similar to those in acts for passenger cars and goods vehicles. The Regulation contains also the list of informations that have to be available (service handbooks, technical manuals, wiring diagrams etc.). It is a possibility given to manufacturers that they may charge reasonable and proportionate fees for access to this information.

3.2.16. *Chapter XVI: Designation and notification of technical services*

This Chapter contains requirements for technical services that are designated by the approval authorities as testing laboratory for performing tests or as conformity assessment body performing initial assessment and other test or checks. There are also articles regarding the designation of the technical service into one of the four categories, regarding the in-house technical services of the manufacturer and regarding the assessment of the skills of the technical services. In this Chapter we can find also the procedures for notifications of technical services to the European Commission and of reporting about changes as well as obligations of technical services about their work and reporting.

3.2.17. *Chapter XVII: Implementing acts and delegated acts*

In this Chapter we could find information which implementing acts will be adopted by the European Commission for the full implementation of this Regulation. It also states that the European Commission will be assisted by the »Technical Committee – Agricultural Vehicles«

3.2.18. *Chapter XVIII: Final provisions*

In the last Chapter of this Regulation we find penalties for the situations when the obligations of this Regulation have been violated. Furthermore, there are transitional provisions, dates for sending reports about the use of approval procedures and time-limits for reports on individual approvals for vehicles per year before year 2016 and on national rules for those procedures. There is an article regarding the repealing of directives and about the date of entering into force. This Regulation entered into force on twentieth day following its publication in the Official Journal of the European Union and it shall apply from 1 January 2016.

3.2.19. *Annex I: List of requirements for the purposes of vehicle EU type-approval*

This Annex is probably the most important part of this Regulation because there are in the table listed all technical requirements for EU type-approval for different categories of agriculture and forestry vehicles. In the table we find for each subject a reference to a relevant article in this Regulation and a reference to a relevant regulatory act, EU or UNECE Regulation or OECD Codes.

3.2.20. *Annex II: Limits for small series*

This Annex set limits of tractors categories T and C produced in small series made available on the market, registered or entered into service per year in each Member State. For tractors category T this limit is set at 150 and for tractors category C at 50 units.

3.2.21. *Annex III: Correlation table*

In this Annex is shown the transposing of articles from the recent framework Directive (2003/37/EC) to this Regulation.

4. CONCLUSIONS

This Regulation has introduced many new features to the field of agriculture and forestry vehicles. These are in the approval procedures and also in other relevant aspects of the work especially in market surveillance. In the beginning of the work this will bring quite a lot of challenges for manufacturers and also to approval authorities and technical services. Fortunately the European Commission is willing to help manufacturers of agricultural and forestry vehicles, approval authorities and technical services on meetings and also on other ways.

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Professional paper

NEW EU TYPE-APPROVAL LEGISLATION FOR AGRICULTURAL AND FORESTRY VEHICLES

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A b s t r a c t: In the Official Journal No. 167 from 2013 the new Regulation (EU) No 167/2013 of the European Parliament and of the Council of 5 February 2013 on the approval and market surveillance of agricultural and forestry vehicles has been published and the framework for the new legislation structure for agricultural and forestry vehicles has been set. Following the recommendations from the Competitive Automotive Regulatory System for the 21st century (CARS 21) report, the European Commission prepared and in year 2015 published in the Official Journal all relevant legislation acts and with this prepared the complete new EU type-approval regulation for agriculture and forestry vehicles. This new system will start on January 1, 2016 when the existing framework Directive 2003/37/EC and their 23 separate Directives on will be repealed. This paper describes the content of all legislations acts followed by Regulation (EU) No 167/2013.

Key words: EU legislation; agricultural vehicles; forestry vehicles; approval

НОВА ЛЕГИСЛАТИВА НА ЕУ ЗА ОДОБРУВАЊЕ НА ТИПОТ НА ЗЕМЈОДЕЛСКИ И ШУМСКИ ВОЗИЛА

А п с т р а к т: Во Службен весник на ЕУ бр. 167 од 2013 е објавена новата Регулатива (ЕУ) бр. 167/2013 на Европскиот Парламент и на Советот од 5 февруари 2013, која се однесува на одобрувањето и на надзорот на пазарот на земјоделските и на шумските возила. Таа ги следи препораките на Системот за регулирање на конкурентноста во амвтомобилноста за 21-от век (CARS 21) што го подготви Европската Комисија и во 2015 година во Службен весник ги објави сите релевантни легислативни акти и со тоа е подготвена нова ЕУ регулатива за одобрување на типот на земјоделски и шумски возила. Овој нов систем стартува на 1 јануари 2016 кога постојната рамковна директива 2003/37/EC и нејзините одделни 23 директиви се повлечени. Овој труд ја опишува содржината на сите легислативни акти кои се проследени од Регулативата (EU) бр. 167/2013.

Клучни зборови: ЕУ легислатива; земјоделки возила; шумски возила; одобрување

1. INTRODUCTION

Until the end of 2015 and from the year 2013 the framework directive for agricultural and forestry tractors is the “Directive 2003/37/EC of the European Parliament and of the Council of 26 May 2003 on type-approval of agricultural or forestry tractors, their trailers and interchangeable towed machinery, together with their systems, components and separate technical units and repealing Directive 74/150/EEC” [1]. Under this Directive there are 23 separate directives with several amendments and corrections that cover all relevant and important parts, elements and systems of agriculture and forestry tractors. Beside this agricultural and forestry vehicles are also regulated with several UNECE Regulations prepared in Geneva on World Forum for Harmonization of Vehicle Regulations (WP.29) and some OECD Codes done in Paris that content very similar technical requirements and test procedures to above mentioned separate directives. So the type-approval system is very strictly regulated and therefore also very complicated for the vehicle producers and also for type-approval authorities and technical services. Every European Union Member State has to transpose all these directives in their national law and this is a huge work for technicians and layers.

In the Republic of Slovenia we transpose the framework Directive 2003/37/EC in the national legislation with the "Rules on approval of agricultural and forestry tractors" [2]. We prepared then also 23 technical specifications for vehicles that contain consolidated texts of 23 separate directives together with their amendments, modifications and corrections. They are not published in the Slovenian Official Journal but only the list of valid technical specifications is printed in it. As equivalent legislation we accept also type-approval based on UNECE Regulations and OECD Codes test reports. The complete legislation is available on the official website of the Ministry of Infrastructure and is regularly updated [11], [12].

In 2010 the European Commission started with the preparation of the complete new legislation in accordance with recommendations of "Competitive Automotive Regulatory System for the 21st century" (CARS 21) [3]. Final report of CARS 21 concluds that most of the legislation in force should be maintained for the protection of citizens and the environment, a simplification exercise should be undertaken so as to rationalize the regulatory framework and move towards international harmonization of requirements. On 2 March 2013 the new Regulation (EU) No 167/2013 of the European Parliament and of the Council of 5 February 2013 on the approval and market surveillance of agricultural and forestry vehicles was published [4]. This is the so called "mother regulation" that regulate all technical requirements for agricultural and forestry vehicles before putting on the market and are harmonized in all European Union Member States. The Regulation entered into force the twentieth day after its publication, but it shall apply from 1 January 2016 [10]. And because this is a Regulation and not a Directive, which is automatically valid in all European Union Member States there is no work for the type-approval authorities in European Union Member States with the transposition to the national law.

Immediate after this publication European Commission started a work on delegated acts and involved in this process a lot of experts from all European Union Member States and manufacturers of agriculture and forestry vehicles. European Commission organized several meetings and new acts have been developed and finished at the end of 2014. The work is now done and all new Commission Regulations have been published in the Official Journal of the European Union.

2. OVERVIEW OF ALL NEW ACTS

2.1. *General information*

All Commission Delegated Regulations cover all agriculture and forestry vehicles and not only agriculture and forestry tractors. Type-approval requirements are now prepared for agricultural or forestry tractors, their trailers and interchangeable towed machinery, together with their systems, components and separate technical units. Constructional and technical requirements are now joined in only four acts instead of 23. If there is European or international standard or UNECE Regulation for system, component or separate technical unit, the regulation uses only the reference to such document and therefore there is no duplication of legislation. With referring to UNECE Regulations these Commission Regulations follow the technical progress because ENECE Regulations are constantly amended. On the other side important modifications to update the technical progress or extending the scope to further vehicle categories or to increase the level of safety will be done by the modifications of the Commission Regulation [13], [14]. All administrative requirements are joined in one special act and therefore the "paper work" in simpler than the existing one. In all acts we have the consistency of the terminology used with the respect to the EU Whole vehicle type-approval (WVTA) process.

2.2. *Vehicle construction and general requirements for the approval*

Vehicle construction and general requirements for the approval are prescribed in Commission Delegated Regulation (EU) No 1322/2014 of 19 September 2014 supplementing and amending Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle construction and general requirements for the approval of agricultural and forestry vehicles [5]. This is the first big piece of legislation with more than 300 pages and with 30 annexes. This Regulation prescribed test procedures and requirements for roll-over protection structures (static and dynamic testing), for falling object protection structures, protection against penetrating objects, protection against other mechanical hazards, protection against hazardous substances, passenger seats, driver's exposure to noise level, driving seat, operating space and for access to the driving position, power take-offs, protection of driving components, seat-belt anchorages, safety belts, exhaust systems, operator's manual, control devices, guards and protective devices, warnings, markings, materials, products and batteries. In the Annex I we could find a list of UNECE Regulations that are directly applicable for the type-approval and on such way there is no duplication of legislation. OECD Codes are also recognized for type-approval procedures and this is prescribed in the Annex II. This Regulation introduced also the virtual testing that is new topic on this field. In the Regulation we could find also the requirements for conformity of production, about the access to repair and maintenance information and performance standards and assessment of technical services.

2.3. *Vehicle braking requirements*

Vehicle braking requirements are prescribed in Commission Delegated Regulation (EU) 2015/68 of 15 October 2014 supplementing Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle braking requirements for the approval of agricultural and forestry vehicles [6]. This Regulation updates and supplements in line with technical progress current type-approval requirements regarding the braking safety on agriculture and forestry vehicles. This act has in annexes requirements from European (CEN/CENELEC) and international (ISO) standards as well as from UNECE Regulation 13 that prescribed provisions concerning the approval of vehicles of categories M (motor vehicles designed and constructed primarily for the carriage of persons and their luggage), N (motor vehicles designed and constructed primarily for the carriage of goods) and O (trailers) with regard to braking. Because of the technical progress it contains specific provisions for energy reservoirs, vehicles with hydrostatic drive, vehicles with inertia braking systems, vehicles with complex electronic control systems, anti-lock braking systems and electronically controlled braking systems. Anti-lock braking systems are not yet widely available for vehicles with a design speed between 40 km/h and 60 km/h and therefore for those vehicles the introduction of anti-lock braking system should be confirmed after a final assessment by the Commission of the availability of such system that has to be done at the latest by 31 December 2016. This Regulation also includes stricter requirements on brake control of towed vehicles and brake coupling between the tractor and towed vehicles than older Council Directive 76/432/EEC.

2.4. *Environmental and propulsion unit performance requirements*

Environmental and propulsion unit performance requirements are prescribed in Commission Delegated Regulation (EU) 2015/96 of 1 October 2014 supplementing Regulation (EU) No 167/2013 of the European Parliament and of the Council as regards environmental and propulsion unit performance requirements of agricultural and forestry vehicles [7]. This Regulation stipulates the detailed technical provisions and test procedures for vehicle manufacturers and other stakeholders to determine the propulsion unit performance of agricultural and forestry vehicles. With reference to Directive 97/68/EC on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate matter pollutants from internal combustion engines to be installed in non-road mobile machinery this Regulation sets-out measurement requirements and emission limits for internal combustion engines used in agricultural and forestry vehicles. It covers the pollutant exhaust emissions and the external sound level. The limit values for external sound level are defined in the Regluation (EU) No 167/2013 (tractors with an unladen mass in running order of more than 1500 kg (89 dB(A)) and for those that the mass is not more than 1500 kg (85 dB(A)).

2.5. *Vehicle functional safety requirements*

Vehicle functional safety requirements are prescribed in Commission Delegated Regulation (EU) 2015/208 of 8 December 2014 supplementing Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle functional safety requirements for the approval of agricultural and forestry vehicles [8]. This is also a big piece of legislation with more than 170 pages and with 34 annexes. To avoid the duplication of legislation this act is very much referring to European and international standards and UNECE Regulations. This Regulation prescribed test procedures and requirements for vehicle structure integrity, speed governors, speed-limitation devices, steering, speedometers, the field of vision, glazing, rear-view mirrors, lighting, light-signalling devices and their light sources, electromagnetic compatibility, heating systems, fuel tanks, towing devices, tyres, spray-suppression systems, reverse gear, tracks etc. This Regulation allows (with a few exemptions) national authorities also to grant national type-approval to a type of vehicle, system, component or separate technical unit.

2.6. *Administrative requirements*

Administrative requirements are prescribed in Commission Implementing Regulation (EU) 2015/504 of 11 March 2015 implementing Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to the administrative requirements for the approval and market surveillance of agricultural and forestry vehicles [9]. This Regulation sets out the detailed administrative requirements regarding the templates of documents, certificates, test reports, EU type-approval mark and statutory plate to harmonise all aspects related to the procedure of authorisation for placing on the market and entry into service. It prescribed also the template for the manufacturer's certificate on access to vehicle on-board diagnostics (OBD) and to vehicle repair and maintenance information. These requirements are new in the area of agricultural and forestry vehicles. In the Annex IX there is a list of parts or equipment which may pose a serious risk to the correct functioning of essential systems.

CONCLUSIONS

All this regulations have been prepared in time and from 1 January 2016 all manufacturers of agricultural and forestry vehicles, approval authorities and technical services started using them. We are all aware that problems will arise but legislation is a "living thing". The European Commission has already published in the EU Official Journal some corrections and supplements of these Regulations. The European Commission and some EU Member States also prepared some corrections and supplements for above mentioned acts and we will discussed about this on next meetings of Working Group of Agriculture Tractors.

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Original scientific paper

PERCEPTION OF RISK MANAGEMENT AND ITS IMPACT ON PROPOSED RISK MANAGEMENT FRAMEWORK FOR IT-CENTRIC MICRO, SMALL AND MEDIUM ENTERPRICES

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A b s t r a c t: Based on survey on perception of risk assessment and management among various IT-intensive organization in different countries, over 150 respondents majority from MSMEs in the Balkans gave their responses on both past experiences with risk assessment and management, and their expectation for the future. The key findings included that (1) only 45% of the MSME are doing risk assessment; (2) when done it is part of a management system implementation or a business plan/strategy; (3) risk assessment is doable, but has challenges in evaluation of risk or identification of mitigation measures; (4) scope should be companywide; (5) it should not last too long and should be repeated annually; (6) it should be done using focus groups and mixed but simple qualitative and quantitative models. These findings supported the initial conclusions from the direct work with companies in implementation of risk management, and refined the proposed risk management framework for IT-centric MSMEs and its four main elements: scope, people, processes and tools.

Key words: IT-centric MSMEs; risk assessment; risk management framework; perception of risk; field survey

ПЕРЦЕПЦИЈА НА УПРАВУВАЊЕ СО РИЗИК И НЕГОВОТО ВЛИЈАНИЕ ВРЗ ПРЕДЛОЖЕНАТА РАМКА ЗА УПРАВУВАЊЕ СО РИЗИЦИ ВО IT-ИНТЕНЗИВНИ МИКРО, МАЛИ И СРЕДНИ ПРЕТПРИЈАТИЈА

А п с т р а к т: Базирано на теренска анализа за перцепцијата за управување со ризик и негова процена помеѓу разни IT-интензивни организации од разни држави,. над 150 учесници од ММСП (микро, мали и средни претпријатија) од Балканот ги дадоа своите мислења за минатите искуства со оцена на ризик и управување со ризици, како и за нивните очекувања за иднината. Клучните наоди се: (1) околу 45% од ММСП спроведуваат оцена на ризици; (2) кога се спроведуваат активностите, тие се дел од воведување на системи за управување или деловни стратегии и бизнис-планови; (3) оцена на ризици е спроводлива, но има предизвици во делот на вреднување на ризиците и идентификација на ублажувачки мерки; (4) управувањето со ризик треба да е во делокругот на целата компанија; (5) активноста не треба да трае многу долго и треба да се спроведува на годишно nivo; (6) треба да се спроведува преку одбрани групи и мешани, но едноставни, модели со квалитативни и квантитативни оцени. Овие наоди ги поддржуваат иницијалите наоди од директната работа со компании при воведување на управување со ризик и придонесуваат за прочистување на предложената методологија/рамка за управување со ризици во IT-интензивни ММСП и нејзините четири главни елементи: опсег, луѓе, процеси и алатки.

Клучни зборови: IT-интензивни ММСП; оцена на ризици; рамка за управување со ризици; перцепција на ризик, теренско истражување

INTRODUCTION

This paper summarizes the main findings and conclusions from the field survey on perceptions of risk management among professionals from IT-intensive organizations. The survey was conducted as part of a PhD research focused on development of new risk management framework for IT-intensive micro and small enterprises.

Prior to conducting this survey, the research team did extensive literature review and direct work with organizations from the target group.

What was found is that there is a discrepancy between the risk management frameworks and risk assessment models in academic research [1] and the ones acceptable for utilization in actual companies. Even more that the current approaches are developed for large organization and are difficult to implement in micro and small companies. The development of ISO30001 [2, p. 3] as a risk management framework was a step in a good direction as it presented a generic and simple enough approach that could be used in the target group – IT-centric MSMEs. The focus of the research was to identify the perception of the IT intensive organizations about risk assessment and risk management in general, and to give guidance on what factors influence the value they get from the exercise.

OVERVIEW OF RISK MANAGEMENT FRAMEWORKS

Nowadays, there are several types of risk management methodologies, some of them issued by national and international organizations such as ISO, NIST, AS/NZS, BSI, others issued by professional organizations such as ISACA or COSO, and the rest presented by research projects. Each of these methods has been developed to meet a particular need so they have a vast scope of application, structure and steps. The common goal of these methods is to enable organizations to conduct risk assessment exercises and then effectively manage the risks by minimizing them to an acceptable level [9].

Table 1 provides a comparative overview of the elements of the various frameworks, methodologies and/or standards.

Vorster and Labuschagne [8] in their work go even deeper in the analysis focusing solely on the methodologies for information security risk analysis and define a framework for comparing them. The objective of their framework is to assist the organization in the selection process of the most suitable methodology and/or framework. The elements than they are taking into consideration include:

- Whether risk analysis is done on single assets or groups of assets.
- Where in the methodology risk analysis is done.
- The people involved in the risk analysis.
- The main formulas used.
- Whether the results of the methodology are relative or absolute.

Table 1

Overview of elements in risk management frameworks and methodologies

Type of framework	Main elements	Resource
Generic risk management frameworks	11 principles for managing risks 5 segments of framework: mandate and commitment; design framework; implement risk management; monitor and review the framework; continual improvement 5 steps of process: establish the context; risk assessment; risk treatment; monitoring and review; communication and consultation	ISO31000:2009 Risk Management Standard [2]
	It has 4 sub-processes: Risk assessment process; Risk treatment process; Risk communication process; Risk review and monitoring process.	Corpuz and Barnes in their paper on integration information security policy into corporate risk management [15]
Information security risk management frameworks	The tiers are: Organization, mission / business processes and information systems, while the phases are: Frame, Assess, Respond and Monitor	NIST SP800-39: Managing Information Security Risk [16]
	6 steps of process: context establishment; risk assessment; risk treatment; risk acceptance; monitoring and review; risk communication.	ISO27005:2008 Information Security Risk Management [12]
	Views: STROPE – strategy, technology, organization, people, and environment Phases: DMAIC – define, measure, analyze, improve, and control cyclic phases.	Information security risk management (ISRM) framework for enterprises using IT [14]
IT Risk management frameworks	Domains: Risk governance, Risk evaluation and Risk response	Risk IT framework [6]
Operational risk management framework	Components: identify, assess, respond to and control risk	COSO Enterprise risk management integrated framework [17]
	Elements: 1. leadership, 2. management, 3. risk, and 4. tools.	RMA Operational risk management framework [18]

Some of these criteria tightly relate to the risk management considerations we have identified in the following section for the IT-centric micro and small companies.

METHODOLOGY FOR THE SURVEY AND SAMPLE

The design of the survey questions was based on the elements encountered in the literature review and the main aspects that challenged the organization during the implementation of risk management. It as well covered elements that we have already identified as a possible solution to the challenges such as people, policy, methodology and processes and tools [3]. The survey was structured in 7 segments with 26 questions in total:

- Introduction – 0 questions.
- Demographic section – 7 questions.
- Questions on risk assessment – 1 question.
- Questions on experience with risk assessment – 9 questions.
- Questions on reasons for not doing risk assessments – 1 question.
- Questions on future risk assessments – 6 questions.
- Closing questions – 2 questions.

It was distributed using e-survey tool, Survey monkey, to large population using direct e-mails, professional groups for risk management and information security on social media, IT business associations, etc. 157 responses were collected in a 15 day period in February – March 2017. 68% of the responses were complete, and the further analysis reflect on the complete responses.

When analyzed, the sample with complete responses, included representatives working in sectors such as IT services, IT outsourcing, Business Process Outsourcing, Telecoms, Banking, Government institutions, etc. Regarding size, the sample represents a equal spread among micro, small, medium and large organizations, with actual 74% in our target group of MSMEs. 50% of the respondent are from organization incorporated in Macedonia, and a larger representation comes from Serbia, Kosovo, other EU countries, Kenya, Bangladesh and Turkey. Majority of the respondents are on decision-making positions in their respective organizations.

KEY FINDINGS

General findings

Our of all the respondents, not all have performed risk assessments prior to the survey. Figure 1 shows the distribution where 54% have done it, and the rest even though some have considered doing it – haven't so far.

Those who haven't conducted risk assessment so far identified that the reasons were that they do not see much benefit in it, or that it seemed overly complex. Those who did perform risk assessment as a main reason had stated that it was part of a management system implementation or part of a strategy/business plan. The most frequently named methodology that was used for the risk management was ISO27001/ISO27005 that focus on information security risks.

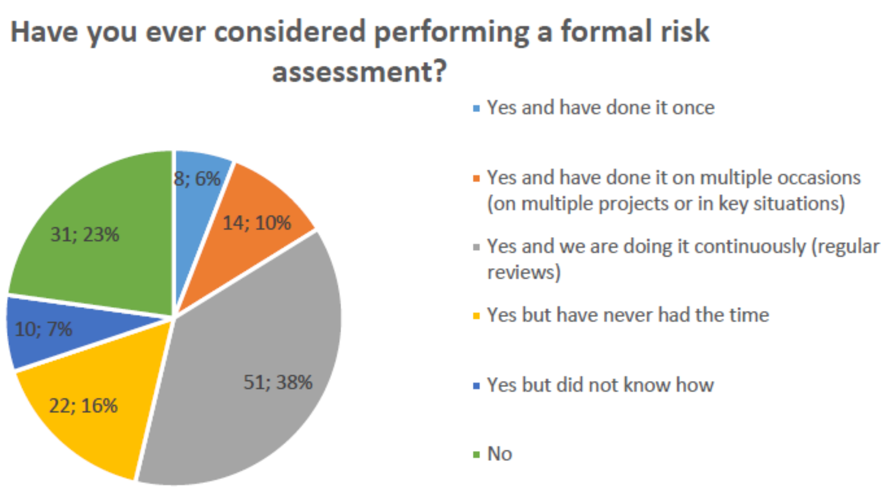

Fig. 1. Previous experience with risk assessment

Another set of question was focused on the perceived challenges for doing risk management. As expected, some differences in perception existed depending on the size of the organization, as shown on the Figure 2. The grading is from 1 – impossible to 5 – easy. It can be noted that regardless of size, all elements and phases of risk management were considered as at least doable. Most difficult ones for micro and small companies were evaluation of risk, while for the large organizations was identification of mitigation actions.

Aside of challenges, the respondents were asked about benefits from risk assessments. For 54,1% of the respondents the main benefit was that it identified where they should improve to mitigate risks, and for almost 30% it had a teambuilding effect. For micro and small organizations, even though the results of the risk assessment were not unexpected, they helped the organization make better decisions for growth, new products and new projects. The variance based on size of organization is depicted in Figure 3.

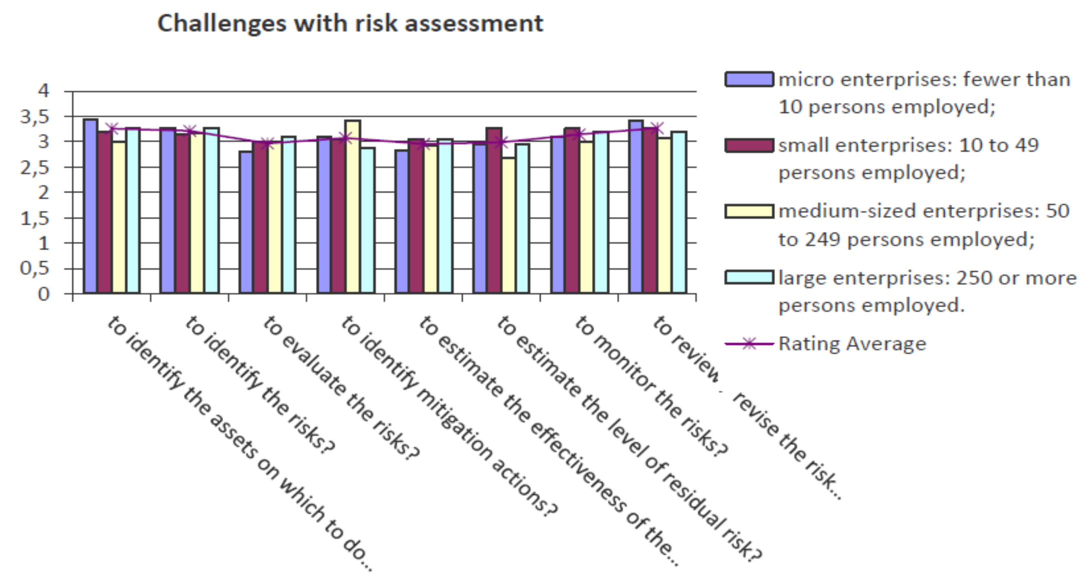

Fig. 2. Challenges in implementer per size of organization

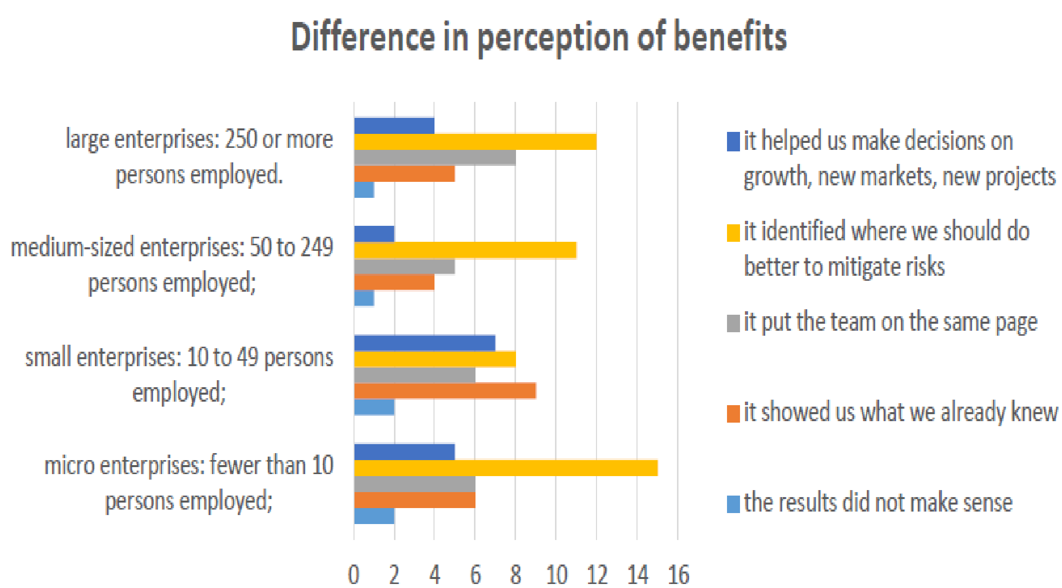

Fig. 3. Difference in perception of benefits

Findings on expectations

The perception of future benefits was surveyed in several areas which were identified as part of the new proposed Risk Management Framework for IT-centric MSMEs. During the analysis the differences in opinion between respondents who have and who have not previous risk experience were considered.

Area: Scope of risk assessment and management

The scope options that the respondents could choose from were identified based on the previous experience with implementation of risk assessment in IT-centric MSMEs, but as well on the prevailing good practice [1], [2], [4], [5], [5]–[8]. The provided options to select for scope of risk assessment and management in the survey included: IT and security risks, operation risks, compliance risks, financial risks, strategic risks, other to be specified. Multiple selections were allowed for this question. Looking at the entire population of respondents, *the top identified options for the scope of risk management were: operational risks, strategic risks and IT/security risks*. The sub-population that had no previous risk assessment experience as well identified the financial risks as important. The Figure 4 describes the prioritization of scope elements by size of organization.

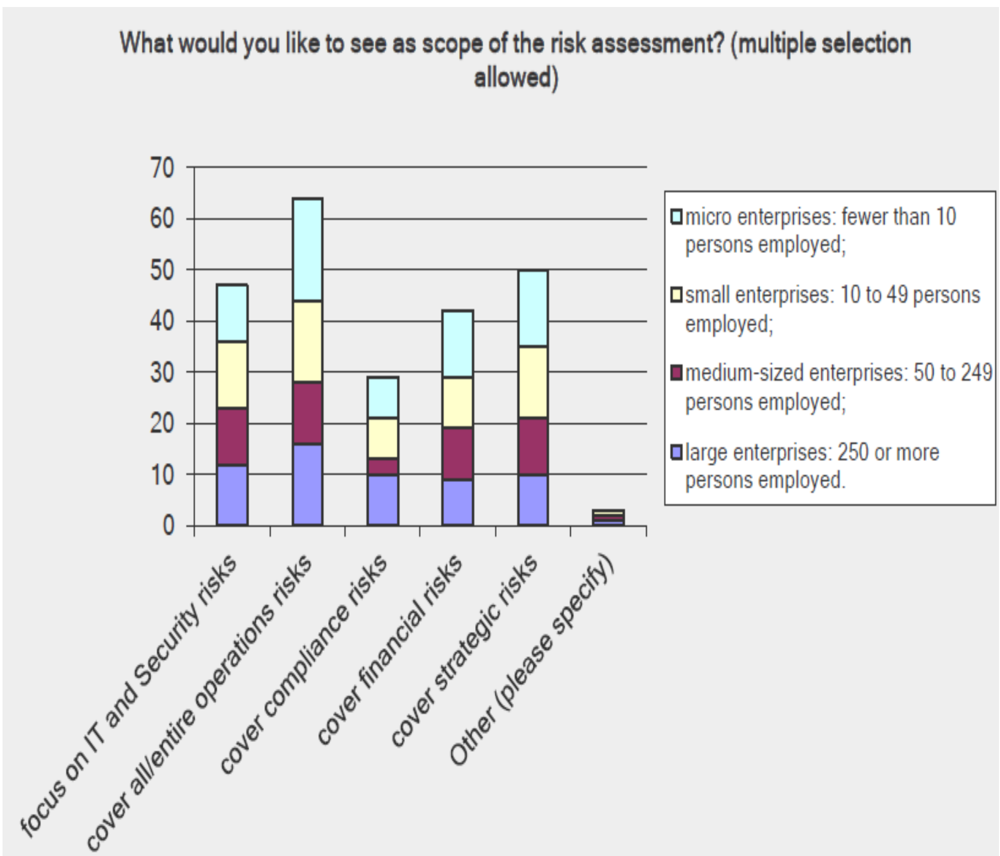

Fig. 4. Priority of scope elements by size of organization

Area: Size and composition of risk assessment teams

As *people* is one of the main elements of the new proposed risk management framework for IT-centric MSMEs [3], it is was as well included in the survey for expectation of future risk assessments. Based on the responses about their past experiences, micro and small companies identified that 2–4 persons teams are ideal, while for the medium and large it was up to 10 people. On the composition of the team, the most selected options included: representatives from all departments, top management and IT staff. 40% of the organizations that had previous experience in risk assessment and management indicated that risk professionals or dedicated risk personnel is needed in the team.

Area: Modality for performing the assessment

As important as the framework for risk assessment is, so is the modality or the way how it will be implemented in practice, as that is where the organizations stuggle and get lost in the depth and complexity of the topic. When asked about the preferred modality, the sample population chose the following three as the most preferred: facilitated group workshop, delegated to various individuals using a computer cool and risk team with subsequent consultation. The following diagram (Figure 5) shows the distribution of the answers among the respondents.

Interesting finding is the variance between the responses from those who had and those who had no prior risk experience in the sense that the organizations that had not have prior experience with doing risk assessment had a higher preference for using a computerized tool than consultation with a risk team, while those with experience made the opposite selection.

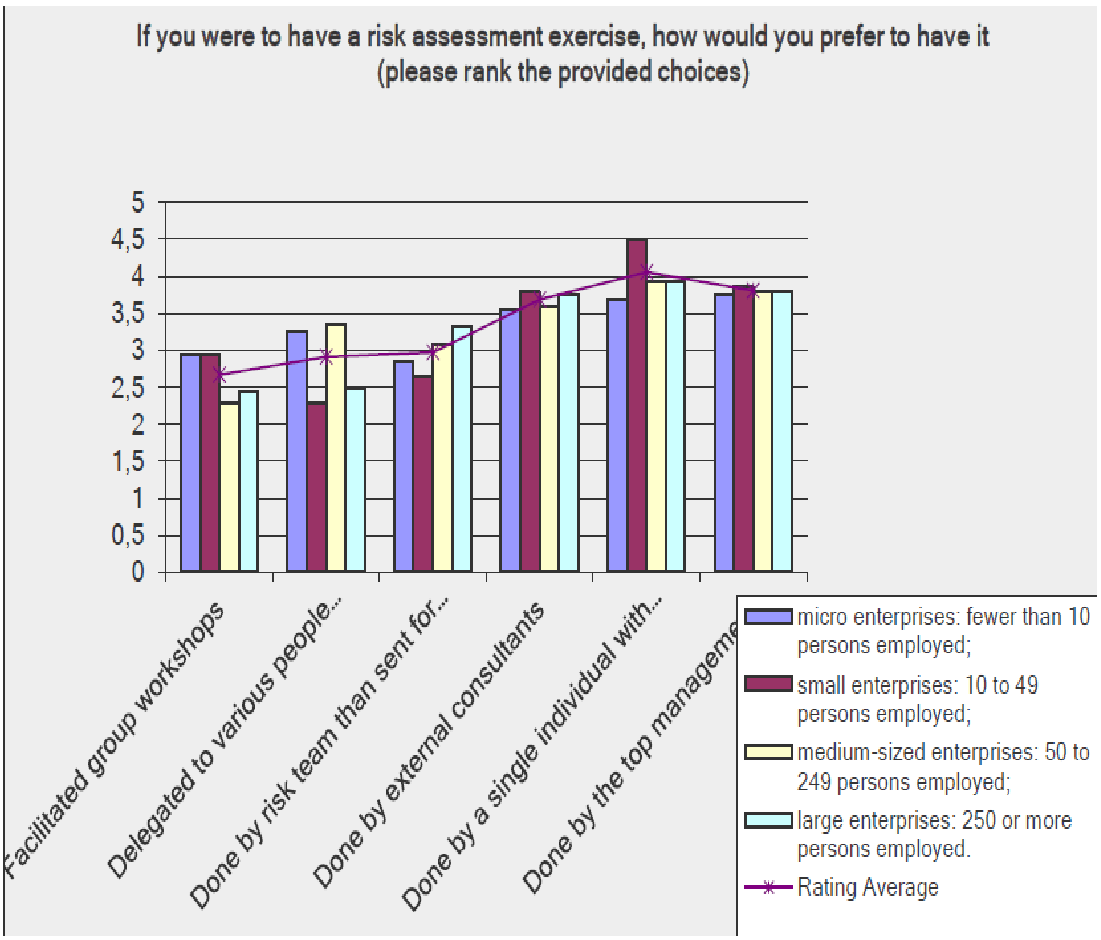

Fig. 5. Modality of risk exercise

Area: Valuation models for risks

Maybe the biggest difference between academic and practical risk assessment is in the valuation models [5]. Current research work ventures in the direction of fuzzy models [9], complex quantitative models [10], economic models [11]. These models based on extensive scientific research provide a very in-depth approach and analysis of the value of the specific risks depending on multitude of factors. But, at the same time, these models are very difficult and time consuming for managers to implement in risk assessments in organizations. Another obstacle for implementation of these models is the need for large amounts of data and stronger mathematical skills. Based on the experiences in implementation of risk assessments in MSMEs, we have found that they prefer the quick and simple model. During the survey, the questions was posed to the sample population and their priority was a mix of qualitative and quantitative model, using value ranges from low to high or from 1 to 10.

Area: Duration of risk management exercises

The existing risk management frameworks do not give estimates or guidance on duration of risk assessment exercises [2], [6], [12], [7]. On the other hand, that is a deciding factor for managers in organizations – when will that have the result as it is needed for making decisions. The surveyed population, comprising of over 150 organizations was with equal distribution of micro, small, medium and large organization as shown on the following diagram (Figure 6).

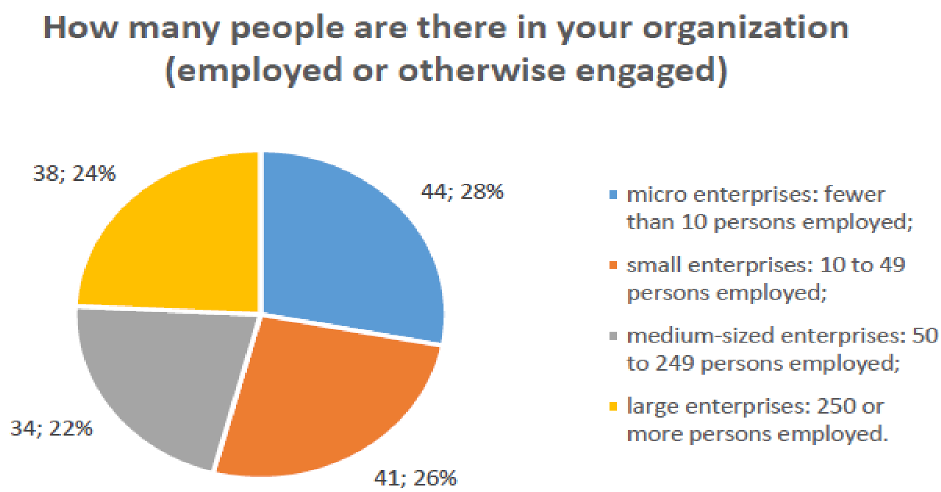

Fig. 6. Distribution of respondents by size of organization

Regardless of their size, the predominant answer was that the duration of the risk assessment exercise should be 2–4 weeks. Other well represented answers were: as long as it takes and 1–2 months.

Area: Frequency of review

The risk management is a continual process, where risk assessments are done on regular basis [2]. Even though the international standard on risk management ISO31000 recommends "regular review at least annually" [2, p. 3] it is up to the organization to decide its frequency. Based on the survey results, it can be seen that this recommendation is taken seriously as it was the most dominant response. Other significant responses included review on quarterly basis as well as review per project or significant change.

IMPACT OF FINDINGS ON PROPOSED FRAMEWORK

Based on practical work on implementation of risk management in IT-centric MSMEs in the Balkans, in 2012 we identified the following challenges for risk assessment [3]:

- Need for integrated approach to treat various types of risks.
- Need for comprehensive and usable methodology.

The same challenges were confirmed by the findings from the survey, but additional concerns were raised such as getting value out of the risk assessment.

These challenges were addressed in our proposed risk management framework for IT-centric MSMEs that covered the four key elements: people, processes, policy and tools [13].

The new findings from the conducted survey indicate that the initially proposed risk management framework needs to be refined and extended. Specifically, the redefinition of the "people" element to include guidance on the composition of the team involved in risk assessment; and "methodology and processes" to include guidance on duration and frequency. The extension of the framework should be in adding an element for "valuation/assessment" where the models for valuation of the risks will be elaborated.

CONCLUSIONS

Risk management is an activity of importance for all types of organization, but MSMEs are performing it less regularly and more intuitive. As confirmed by the survey, even though all types of organizations are finding risk assessment doable, challenges exist and leveraging on the past experience and existing framework and guidelines can help in future risk exercises. Light and simple approach, in short time period with a consultative multidisciplinary team is the preferred way of doing risk assessment for the IT-centric MSMEs. Future work should be focused on refinement of the proposed risk frameworks to reflect on these preferences.

Acknowledgment: Sincere gratitude to the organizations and individuals who took part in the survey and in our previous work on testing the risk management framework for IT-centric MSMEs.

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Original scientific paper

DESCRIPTION AND ANALYSIS OF ENERGY MANAGEMENT INFORMATION SYSTEMS, AS A USEFUL MANAGEMENT TOOL

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A b s t r a c t: The life on this planet is not sustainable without energy and as energy consumption is rapidly and uncontrollably increasing, it is important and urgent to reduce this consumption without harming the quality and comfort. Both suppliers and consumers of energy are facing challenges, suppliers need to develop and implement technologies for more efficient and cleaner supply, whereas consumers to reduce the demand by increasing efficiency of use. Energy Management Information System (EMIS) enables effective measurement and accordingly, planning and decision making regarding management of energy use and costs. The goal of this article is to elude the implementation process as well as the ongoing operation within every EMIS. As a performance management system, its designed and implementation is dependent on the site and facility, therefore its features vary regarding needs. Despite that, EMIS has shown as beneficial, trough enhancing productivity and efficiency and by that providing gains for each consumer, as individual or as enterprise. Its operational cycle consists of 4 repetitive phases, ensuring continuous control and refinement.

Key words: energy efficiency; energy management information system; energy performance; smart grid

ОПИС И АНАЛИЗА НА ИНФОРМАЦИСКИТЕ СИСТЕМИ ЗА ЕНЕРГЕТСКИОТ МЕНАЏМЕНТ, КАКО КОРИСНА УПРАВУВАЧКА АЛАТКА

А п с т р а к т: Животот не може да биде одржлив без енергија, а бидејќи потрошувачката на енергијата неконтрилорано расте, многу е важно таа да се намали без притоа да се влијае на комфорот и квалиетот на живеење. И диструбутерите и корисниците на енергија се соочуваат со предизвици: дистрибутерите мора да најдат начин да имплементираат технологии за поефикасно и почисто снабдување, а потрошувачите треба да најдат начин да побаруваат помало колиество енергија. Системите за енергетски менаџмент EMIS овозможуваат ефективни мерења и соодветно на тоа планирање и донесување одлуки за процесите поврзани со управувањето со енергијата и со трошоците. Ова истражување се осврнува на процесот на имплементација и ефективна употреба на EMIS. Карактеристиките на системот дополнително зависат од местото и опремата за која се употребуваат, па системот варира во зависност од потребите. И покрај тоа, EMIS покажува корисност преку подобрување на продуктивноста и енергетската ефикасност на системот, и на тој начин дава дополнителни придобивки за корисникот на системот. Оперативниот циклус се состои од четири фази кои се повторуваат и на тој начин се обезбедува континуирана контрола и усовршување.

Клучни зборови: енергетска ефикасност; систем на енергетски менаџмент; енергетски перформанси; паметни мрежи

1. INTRODUCTION

Carbon Trust: "Reducing energy use makes perfect business sense; it saves money, enhances corporate reputation and helps everyone lead the fight against climate change".

Energy Sector is facing uncertainty in prices, both of electricity and carbon, energy infrastructure, economic crisis and most importantly the energy resource quantity in order to satisfy the fast-paced increasing electricity demand. According to many researches of World Energy Council, the energy consumption is projected to increase approximately 40-45%, by 2050, varying regarding different scenarios [1].

Energy management is a circular process that begins with metering the energy consumption and/or production and collecting data. Quantity and quality of data are of high importance, as the shorter the interval of measurement and the more detailed the data is the more precise calculations, predictions can be done. Also patterns can be extracted and the waste of energy can be spotted which will contribute to more energy efficient planning. After quantifying the data and analysing opportunities for energy savings, planning and implementation should be performed. Continuous control and improvement is the official last stage of the process. However, this is an on-going process which requires regular inspection of the system in order to keep up with the current technologies and developments that might present a new opportunity of improvement [2].

As is shown in Figure 1, in order the energy management to provide the expected improvements an efficient flow of data is essential. Therefore, Energy Management Information System should be a fundamental tool implemented within the Energy Management System itself.

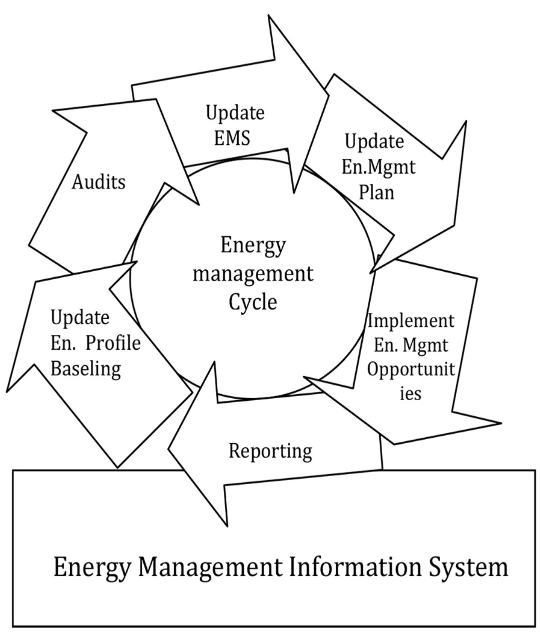

Fig. 1. Energy Management (Reprinted from [20])

Energy Management Information System (further referred as EMIS) is an interactive system for storing, analyzing and representing energy data, inducing energy performance advancement that will be analyzed throughout the thesis.

Successful examples of companies that have implemented as Kodak, eliminating $30 million in annual energy recurring costs, Artisi Consolidated reduced the Electricity cost for $1 million in the first year, New Afton Mine has saved 9 GWh of energy and exceeded their energy objectives etc. are a proof of the effectiveness of EMIS.

2. STATE OF THE ART

As a relatively new tool for energy saving, EMIS has a high potential for research especially due to its relevance in improving performance and productivity. However due to the aforementioned reason sources are limited.

EMIS uses the synergy of information, integration and innovation to help in the overall improvement of a business, simultaneously reducing the footprint of an enterprise.

The basis of the concept is energy management which has been elaborated in numerous books, journals and diverse research reports. EM as concept started evolving since the first oil crises 1973. Since then sufficient data is collected and can be analyzed with little possibilities of mistakes, which leads to reliable sources of the structure and benefits of EM. For the purpose of the following research Energy Management Handbook was used as a reliable source that informs on the analysis, both technical and economical on HVAC systems, control systems, lightning, air quality, energy maintenance, energy resource purchases etc. and advising on measurement and verification of energy savings. This handbook has 8 editions, latest one in 2012, verifying its reliability.

For in-depth analysis of EMIS few reports and papers were considered for relevant.

In general, the researchers agree on the benefits EMIS can provide. Canadian Office of Energy Efficiency of Natural Resource [3], through the handbook has elaborated the advantages of the system, its factors of success as well elements that constitute the Energy System to achieve the goals. However, as expected, the development is differently defined depending on the area of work and the report writers. Differentiation exists among implementation recommendation as most of the information systems need adjustments and customization, making each system unique and therefore carrying different features. Again, the Office aforementioned [3], has listed steps, given below which, have been reordered by Lawrence Berkley National Lab. from US Department of Energy [4] as it starts with inspection of possibilities to integrate it in the existing infrastructure, being step 3 in the first resource.

Most of the resources available show that EM has been most popular in smart buildings and smart grid technologies as most benefits can be received in these areas.

On one side the buildings energy management is mostly researched by companies involved in designing and development of such systems and state agencies, such as Better Buildings Initiative of US Department of Energy [5] whereas smart grid technologies is widely examined by the industry and academics providing in-depth research and reliable results due to instantly realised benefits as well as detected anomalies and potentials for improvements, as elaborated by Aman S., et al. [6]

3. DEVELOPMENT AND IMPLEMENTATION OF EMIS

Energy consumption which, as above stated, is substantially increasing due to the economic growth and technology development, has two parties involved in each transaction: supplier and consumer. Supplier side, involving both the supplier of energy and the supplier of goods and services that consumes energy have need for energy management, as their incentives are led by higher profits. Since the governments have engaged in working on the climate change issue, regulations regarding energy efficiency have been introduced, which influences the suppliers in their management of resources they deliver.

The demand side requires economic and behavioural analysis in order to create a solution that can help the reduction of energy consumption in the shape of demand response initiatives. An integrated information system can manage both sides reducing the demand and improving efficiency.

Energy management information system has its prime role to support the energy management as part of the overall strategy of the organisation. The system should be developed regarding following factors [3]:

– Particular site, type of facility.

– Processes and plant involved, i.e. if it is industrial facility, the type of plant gives energy intensity and needs.

– Cost of energy, potential savings.

– The urgency of the information necessity.

– Capital availability, for investment in development, implementation and maintenance of EMIS.

– Existing infrastructure: meters and instruments, equipment existing on site will influence the capital investment amount.

– Monitoring and control systems.

– Data bookkeeping, historical data has very important role in future planning.

– Data analysis and reporting systems, the communication in the company and information flow.

– Existing management systems, how the company is managed influences the path of development of EMIS.

Mainly, for multi-site organization, for example, more sophisticated systems are needed, requesting higher capital investments and time as well as costs associated with monitoring. As for a smaller organization the system can be simpler and less comprehensive.

In order the EMIS to be successful in decreasing the energy consumption and improving the procurement, the development should be performed regarding the features stated below. Based on the features the elements as components of EMIS will be considered as follows.

3.1. ISO 50001

As Energy Management System aids energy efficiencies and savings as well as resource conservation, ISO 50001, as standard was developed to support the organizations in the process of quality and environmental management. According to this standard [6], the enterprise and management are responsible to authorize employees accountable for energy management activities, ensure that it is the EMIS established in the company is precisely implemented, maintained and continuously improved. Moreover, it should promote awareness by setting up energy policy which should incentivize, commit employees in the process of performance improvement. Therefore, it should be in compliance with company's strategy, goals and culture and to be regularly reviewed and updated as well as communicated to all levels.

3.2. Feature of EMIS

Generally, the information system should ensure data flow and storage safety, quality insurance, by recognizing gaps and outliers by that mistakes, metering, mapping, verification of changes. Furthermore, EMIS should be able to give clear visualization of energy profiles and perform portfolio benchmarking defining the best practise. Additional features EMIS importing or exporting of data according needs as well as calculation of returns on investment and performing financial analysis. [7]

3.3. Elements of EMIS

An intelligent energy system should have three technologies present and integrated: *flow network*, representing connected transport components that enable the movement of matter or objects such as air, electricity, water, packages, containers, people etc, then *sensor network*, which is a set of devices that measure and report status or condition such as temperature, pressure, location, speed etc. and in the end sensitized object, which is owned or manage and has integrated metering system that reports on its use, for example some appliances can report power consumption. [8] [3]

Therefore, basic elements of EMIS are sensors and instruments, data infrastructure and software tools (marked red on Figure 2).

Commonly, the corporate IT system can be used to network the *data infrastructure* for process monitoring and management, enabling consolidation of data and functioning as a unified system.

Sensors and *instruments* (meters, for energy use and measuring factors influencing the energy use) are connected to the monitoring and control systems (for example SCADA). Within the system *software tools* proceed with data analysis, reports and decisions as well as storing data in the data base for further use.

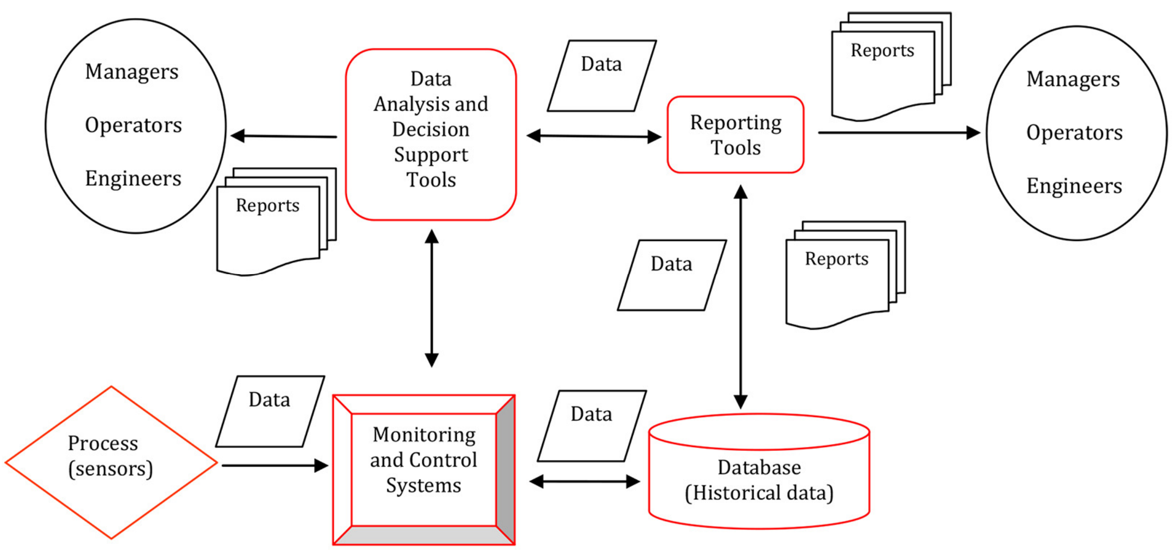

Fig. 2. EMIS elements (Adapted from [8])

3.4. Steps of implementation

Following the analysis of crucial factors, features and elements, the implementation can be defined in 6 steps [3]:

1. *Planning and creating a vision of effective EMIS* for energy saving, reduction of emissions, competitiveness, need for real-time fault diagnostics and by that quality increases. During this phase it important to define the needs of the organization it is intended for, and to simulate in order to assess the usefulness of the system

2. *Design of EMIS*, consideration of measurement issues and definition on type of measurement regarding the data needed. Performance measurement should be presented real time and person in charge should be involved in order to set achievable but aspirational targets, that are evi-

dence based. During this stage the level of comprehensiveness of data should be decided upon, as a trade-off exists between detailed data and cost.

3. Consider *integration into existing systems* is an important step as it can reduce costs of development and implementation. Also integration of EMIS into existing IT systems, means data acquisition can be done for all purpose and integrated all together, reducing the possibility for mistakes and inconsistency of data. Even integrated, certain adjustments and additional inputs and equipment will be required, which should be defined during this evaluation as it will influence in the decision of creating a new system or integrating in the existing one. Another important factor is integration and interaction of technology and people, as certain trainings might be required to encourage employees to share information and up-skill them for the future use of the system. Communicating information can be an issue for certain people, as lack of awareness of benefits or fear of consequences can exist. Overcoming these issues is an important part of management tasks is a successful implementation is to be performed.

4. *Cost/Benefit analysis*, commonly, is of extreme importance so that the project gets accepted. However, it is also hard to estimate the exact annual utility cost saving. According to a research in the UK, approximately 8% can be saved from annual cost with proper implementation of the system. Better estimations can be obtained if the organization can provide data on the areas of the greatest energy use and potential saving as well as launching pilot project that can test and give more precise estimate. On the cost side, expenditures for implanting EMIS should be proportional to the site`s annual utility costs, according [3], the following expenditures are advised (shown on Table 1).

Table 1

Justifiable EMIS capital costs

Annual Utility Costs $	Approximate Justifiable EMIS Capital Cost up to $
125,000	25,000
250,000	40,000
600,000	50,000
1,250,000	150,000

(Reprinted from [3])

Besides the investment costs, the operating costs are of high importance and should be considered to complete this step.

5. Obtain *support from Decision Makers* is the final step of finalizing the initial version. In this stage the energy manager should present the project to senior management, which is responsible for final decision and therefore approval. This implies that if the following stages were properly performed, and the management is skilled and informed as well as aware of the technology advances any company needs to undertake, the project of EMIS will be approved for implementation.

6. *Continuous control* of the performed activities and results to ensure proper implementation and prevention of any kinds of failures and mistakes.

4. OPERATION CYCLE OF EMIS

EMIS consists of four basic repetitive phases: gathering data, opportunities for action and changer, defining specific options, develop guides and control [9].

4.1. Data gathering

Data are raw materials for forming information, which builds up the knowledge regarding a certain situation. Three *categories of energy management data* are defined [9]:

– Consumption;

– Cost, the most important factor of every organization, providing financial information;

– Drivers, any factor influencing the consumption, example weather;

– Drivers can be features of organization`s activity that influences the consumption or certain conditions. Examples of drivers are: weather, hours working, hours of darkness etc.

The process of collecting data is usually very complex, depending on the number of points of collecting data, the method and frequency of data gathering.

Two *methods of collecting data* can be employed [9]:

- *Collecting data from meters*

In order to provide the data, meters and metering periods should be defined. Depending on the situation more than one meter is installed. The metering period, which represents the time between meter readings, is defined based on the needs of precise data. The collection can be performed manually, by staff, or electronically, based on electronic pulses which are proportional to the data collected.

- Collecting data from invoices

In the case where meters cannot be installed or the measurement point is on a remote location. In this case the information in the invoice should be correct, specifying tariffs, details included in order the right calculations of energy consumption to be performed.

Frequency of data collection is defined based on the needs of the system. Frequent reporting, therefore, is needed to capture anomalies in current flow, or energy spikes, which can indicate major (and expensive!) problems if left unchecked. It should be proper to allow problem discovering and solving on time, at least twice the frequency of fluctuations on energy in order to receive more clear data. However, very high frequency may show too much variation leading to wrong assumptions and conclusions, as the variation will be a result of control systems changes instead of real energy performance variation. In general, the frequency of metering should be suitable to get more precise and realistic pattern of consumer behaviour.

Another crucial factor is the *data quality*, or the usefulness of the data. High quality data is most valuable asset, since bad data can seriously harm the business`s credibility and integrity. The core dimensions of data quality are: Completeness, Uniqueness, Timeliness, Validity, Accuracy and Consistency. Completeness of data stands for data without gaps and space for speculation, meaning that all available data has been collected. Data should not have any duplicates reported, so that the risk of assessing out-dated information decreases. Furthermore, regular update of the database is to ensure all changes have been captured up to the date of analysis. Validation of data is performed to control for conformity to the syntax (format, range, type) that has been previously defined. Consistency is defined as absence of difference or uniformity and reliability of repetitive events and Accuracy stands for precision and exactness, if the data is good fit with reality [10].

It is important to explicitly report that *Real Time data* required so that poor performance can be quickly identified, understood and models can be created, by that the solution can be implemented sooner. In order the system to take real time data, the costs are high and the system is more flexible. [3]

4.2. Analysis and Opportunities Spotting

This is a very important step of transformation of data into information and can be done on regular basis in order to plan and evaluate, and can be automated or can be done to investigate a situation. When analyzing the first stage is looking at the energy only, then the energy data and drivers itself to explain the previous figures. A factor that influences the data analysis techniques is the volume of the datasets. For example, the pattern of seasonal consumption is to be explored, monthly data is needed, but heating is not used all the 12 months. Therefore, a weekly data should be used, meaning the data volume is larger.

During this phase it is important not to cause “Paralysis by analysis”, state of over-analyzing and not taking any action, leading to unplanned excessive costs.

To analyze data efficiently, various techniques exist, chosen according to the needed output [9]:

- Normalized Performance Indicators (NPI), kWh per square meter of floor area annually, adjusted for weather, operating hours etc. It is used usually for buildings energy performance in benchmarking process.
- Specific Energy Ratio, kWh per unit of output, used to express performance of industrial processes. It is also called the Specific Energy Consumption, and can be calculated as energy used divided by a production measure (driver).
- Current and Past Comparison, comparing energy performances.
- Trend Line, expressing a direction of the biggest fraction of data points, energy use against time.
- Profiles, consumption patterns over specific time periods (daily, weekly, monthly, yearly), that can be compared with current or past profiles, average values in the profiles and control for different boundaries for the values.
- Contour mapping, 3D display of profiles.
- Lines of best fit, line that best describes the data on a scatter plot. Energy is plotted and a

driver in order to define how it influences the consumption.

- Variances, showing deviation from anticipated energy performance.
- Cumulative sum of variances from standard performance, technique for determining whether a specific measured level of consumption varies significantly from the expected level, or whether the variation is just random "noise".
- Control charts, having a central line for average and upper and lower line as limit lines defined from historical data.

4.3. Targeting the solution, communication and implementation

Outputs from analysis are received in many forms from the System to be used for solving different issues. In order the process to evolve in efficient solution, the conclusion i.e. the output from the analysis has to be communicated, as depicted on Figure 3, transformation of information to action.

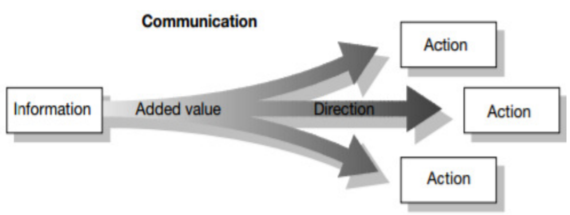

Fig. 3. Processing the information into data land consequently action
(*Reprinted from* [9])

The process of communication is divided into three categories [9]:

– Regular, as a report issued on time basis
– Exception, on a need basis
– Ad-hoc, as a result of requested investigation.

To complete a successful transfer of information it should be decided who are the recipients of information and the exact information to which recipient should be delivered. Miscommunication can lead to implementing inappropriate or inefficient solution or ignoring a situation resulting in unnecessary costs and pollution.

Furthermore, communication too often can lead to information overload and decrease productivity, as infrequent communication can harm further actions.

To conclude, the right information is needed at the right time reported to the right person.

In order an action to be undertaken, information is needed as well as policy should be implemented. Graphical representation of results is the best option of presenting and notifying, as it can be received as information in an easier and more efficient manner.

4.4. Development of guidelines for future use and control

In order the System to function properly and the goals of its implementation to be achieved it is required to have the following [3]:

– Energy data that will help in improving the most affected areas
– Targets, must be regular reviewed and updated, take into account the influencing factors such as: outdoor temperature, operating hours, production rate, hours of occupancy etc.), realistic but optimal and defined after a detailed research and monitoring of past experience and benchmarking. These targets should be communicated with the management and responsible to clarify any issues or misunderstandings in advance.
– Reports on the variation of the real data from targets, and the level of detail depends on the intended audience and their expertise.
– Training of the staff and team building so that no space for speculation and mistakes is left
– Decision support providing a framework on decision making methodology and agreement to shorten and simplify the process of making a decision that tackles more departments/sectors
– Audited success, so to sustain motivation
– Motivation and recognition, means rewarding systems and support from leaders
– Benchmarking and best practises is always beneficial for the organization to measure performance in relation to other companies or sites and represents an excellent learning opportunity. It is important to compare practices that have similarities in activities, conditions and tackle similar markets.

5. ADVANTAGES AND DISADVANTAGES OF EMIS

Energy Management Information System should be a very important part of every successful enterprise and is a valuable asset of a company if managed appropriately. If used properly it will represent a basis for competitiveness by easing the communication, decreasing the linguistic, geographical, cultural gap between countries. Furthermore, the IS is available at any time, making doing business more convenient and ensuring cost effectiveness and productivity boost.

Main purposes of EMIS are recording relevant data, analysis of energy consumption, calculation of energy indicators, recording undertaking energy efficiency measures, identification and development of energy efficiency projects, rising awareness and promoting energy efficiency. Therefore, if it is properly developed, implemented and maintained, the company can benefit from EMIS providing [3]:

- Early detection of poor performance, which can be done based on comparison of actual performance with targets and spotting deviations, enables identification of acute problems (excessive energy consumption and losses) as well as taking corrective actions.
- Evidence of success, validation that actions that had been undertaken have been successful comparing to beforehand deffined benchmark value which takes into consideration the external influences on energy use, such as production, ambient temperature, etc.
- The actual consumption of energy and the price of it.
- Support for decision making, can help in a situation where a difficulty in decision making arises, and the support can come in different forms: guidelines, charts, systems etc based on knowledge-based systems or data mining.
- Effective performance reporting, to ensure that the responsible are taking effective action.
- Auditing of historical operations, helping engineers and managers to learn from the past situations and perform better in the future.
- Identification and justification of energy projects, the improvement investments can be easily justified and opportunities can be revealed.
- Support for energy budgeting and management accounting, historical relationships used for future budgeting. The data can reveal the true price of energy, product specific cost of energy, how the production volumes influence energy cost per ton of product.
- Provides basis for project preparation in order to apply for funding.
- Energy data to other systems such as resource planning systems, scheduling systems, environmental reporting, management information systems, corporate systems etc.

However, EMIS has its downside as of security issues, unemployment and lack of job security (automation of certain activities previously done manually) as well as costs for implementation and maintenance. Since every method of gathering data has costs, choice should be made when costs of the method are equal or lower than savings potentially made with application of that data. Costs are also associated with user licence and trainings if needed. However, maintaining costs are usually the highest and should be considered when calculating. As mentioned, lot of work is processed automatically, performing task by computer that used to be done by people, causing job losses.

Security is one of the main issues, making the system vulnerable to security breaches and if not well protected, unauthorized individuals may have access to confidential data.

Furthermore, the system requires continuous work of operation in cases of manual entries, due to missing data and inability of importing a database. In the case of automatized data entries, the disadvantage, before mentioned disappear but the price of monitoring system increases.

In the end and very important the human factor is present and can influence in achieving the goal as of generating mistakes while working.

6. BARRIERS AND CHALLENGES

As still new and developing technology, the EMIS has lots of challenges to face and potential to improve, keeping pace with the extremely fast technology development.

The basis of the implementation and development lies in the understanding, vision and commitment as well as support of the management. If the management can spot the need of energy management in general and the benefits of information system to support it the development of the company is most certainly in the right direction. However, energy management for a big portion of managers is still seen as unnecessary and even useless. For many the benefits cannot be received immediately, therefore rejecting proposals for any kind of EMIS is more intuitive. Another reason for lack of support among managers is the failure of previous similar projects. For this and above mentioned reasons, the motivation between the management can be on a low level, usually transferred on the employees as well.

In the case of accepted EMIS project, it is crucial that a well-defined company policies exist, explaining goals and objectives and easy-to-understand guidelines that will help the employees of every level understand the need and feel involved in improvement. The policies and directives should be built on procedures and regularly updated due to technological, organizational changes or need-basis from experience.

For every implementation to succeed a very important element is defining and allocating the responsibilities and by that meaning accountability and authority. Furthermore, and obvious element is the budgeting. As mentioned few times across this text, the available budget is crucial as are human resources. The initiator should have a good project elaboration and vision that can be transferred to the CFO or a funding organization (in case of external financial support). The more the project focuses on benefits implication the bigger are the chances of the budget being assigned to the project. For the capital planning two basic types of costs should be accounted for: first cost (for new or replacement equipment) and life-cycle cost (operating efficiency of equipment and the pay-back period which can be most influential in making the decision for implementation of such system.

According to research [11], facility staff asses few thing besides simplicity that valuable to them as connection of EMIS with mail for alerts, data and reports; graphical representation with coded colours, simplest interface possibly without need for training, that would basically shorten the time and reduce the possibility of mistakes.

In order the whole implementation to proceed as flawless as possible, a good training and regular report on savings and improvements is necessary, contributing to the motivation of the involved.

As the above mentioned elements can be crucial to success, certain barriers arise such as lack of interest in energy cost/consumption as long as they are making profits and lack of understanding that energy is a cost that can be reduced or that EMIS can be helpful in increasing overall efficiency. Another obstacle is the lack of resources such as capital and human resources, knowledge and experience. Inability in integration of production data with energy data can be a problem, slowing down the process of Energy Management [12]. One of the biggest fears of managers is risk of the unknown and new technology, here including: competition (companies that have already gained certain experience regarding this technology), unknown on-going costs, technology development and market development as well as fear of political crisis due to instability which influence the markets in general.

7. ENERGY MANAGEMENT SOFTWARE

Even though, EMIS is relatively new concept, it has proved its effectiveness. Many companies have developed software that can be implemented or companies that offer custom-made solutions to adjust the system even more to the company`s characteristics and needs.

Below are shortly elaborated some of the most popular software among companies.

Energy advisor [13], created by Emerson (Figure 4), manages energy consumption and reports and notifies for direction to reduce energy costs. It is convenient as it monitors equipment, since deteriorated equipment consumes more energy.

Utilities direct [14], offered by the company named the same, provides Energy Management and Metering, trough real time data shows energy consumption in 30 min. intervals. It can be implemented in single-site or multi-site company, however It is focused on medium to large companies and larger energy consumers. One of the best features is the flexibility to adjust and switch to different suppliers as well as asset registration and invoice preparation tool.

Sap Energy Management Software [15], by SAP which as a company creates different modules to increase productivity and by that to reduce costs, offers smart metering and analytics as well as demand side management tools. Its features offer cost effective design of strategy that will comply to the environmental regulations. One of the biggest advantages is the integration with financial data and the development of the SAP system on a whole. However, according to some reviews, SAP is generally falling short in user-friendliness of the interface. Therefore, SAP can be beneficial for every company that uses SAP already and/or is able to adapt to the new interface.

Schneider Electric Power Logic ION EEM [16], created by Schneider Electric, focuses on integration of business and energy strategies, making it focused on financial gains and losses more than pollution reduction. This software has powerful graphics and models, visualising solutions. Another benefit is the customization options as well as flexibility in integration and sharing data with other parties and systems.

Fig. 4. Emerson Energy Advisor, left - energy consumption real-time representation, right – reporting (*Reprinted from* [13])

eSightenergy [17], by eSight, focuses on small and large companies and is web-based software, making it easily accessible and has options for pay-as-you-go. Companies can use it for billing, as it provides them with tariff details including 1-minute interval variations.

Credit360 [18], used by Swiss Re and Barclay is concentrated on planning and forecasts promoting sustainability, as it helps the company reduce footprint without cutting into profit and, except energy data, it also collects data on carbon emissions. Although it contributes in making the business greener, it does not improve business productivity as it would be expected.

JouleX [19] (Figure 5), as one of the leaders in IT, CISCO has designed an energy management software solution that monitors, analyses and controls energy usage and according to their sources contributes to reduction of energy costs to up to 60%. Offering flexibility and remote control as well variety of tools of adjustment and reporting. Though very useful and popular, it is more convenient for large data centres and heavy server loads.

Fig. 5. CISCO Energy Management Software (Reprinted from [19])

CONCLUSION

To conclude, the EM systems need to provide the users with easily accessible and operable interface as well as intelligence that will result in savings and profitability as it is the goal for all market participants. Driven by the needs of energy saving and resource depletion, EMIS is advantageous over passive systems of energy data recording as it gives real-time information, notifies, controls and handles the consumption. Above all it will reduce the pollution and enable sustainable economic and social development.

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The **title**, **abstract** and **key words** should be translated in Macedonian language. By the foreign authors Editorial Board will translate in Macedonian language.

In the **introduction** only the most important previous results related to the problem in hand should be briefly reviewed and the aim and importance of the research should be stated.

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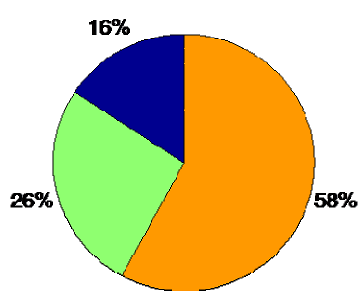

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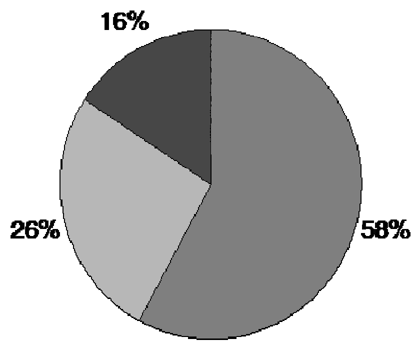

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