SELECTED ASPECTS OF PRODUCTION AND LOGISTICS PROCESSES INFORMATIZATION

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Abstract

Informatization, digitalization and automation of production and logistic processes became a part of a new industrial revolution especially due to the fact that specific and customizable software are used to manage these processes. Informatization and digitalization is the base of automation of production and logistic processes. The basis for informatization and digitalization represented by the development of information system, however, is a set of process innovations. These innovations arise as a consequence of process analysis, without which it is not possible to propose an optimal process structure and its characteristics. The paper presents the results of an empirical research whose aim was to analyse selected aspects of process innovations induced by introduction of production and logistics processes automation.

Keywords: Informatization. Automation. Logistics. Innovations.

1. INTRODUCTION

Importance and mutual connection of production and logistical system is indisputable. While a production process presents the material base for functioning of all other processes and activities (Madicet al. 2016), a logistical process manages, ensures and realizes all the logistical flows and chains among these activities (Malindžák, 2010). Automation of company processes enables replacement of manual and often repeated activities by automatic performance by a suitable software (Abu Rub, Issa, 2012; Panayiotou et al., 2015). In this way a company gets a lot of benefits such as simplification of processes management and control, their mutual synchronization and coordination, decline of labour costs, energy and operating staff costs as well as increase of effectiveness, work quality, etc. Company management can dispose with adequate information concerning the course and duration of individual activities (Samaranayake, 2015, Hänel, Felden, 2015, Kabaale and Kituyi, 2015, Suriadiet al., 2015). According to Janiesch et al. (2014) the main goal of automation is to decrease times of performed tasks and increase their performance. It can be realized without a change of their execution. But the company processes automation itself is preceded by a process audit which is aimed at determination of actual state of company informatization and digitalization, i.e. utilization of information and communication technologies (ICT) and a possibility of information transfer to a digital form and their processing in an electronic form. Within a process audit it is necessary to carry out an analysis of production and logistics processes which presents an essential mean to find out their logical links and mutual interactions. This analysis enables organization to identify potential risks and opportunities and leads to higher effectiveness of their management and improvement of performance of the whole company (Pradabwonget al., 2015; Helquist et al. 2012). Carrying-out of process analysis consequently allows taking the next step - this is modelling and graphic presentation of their mutual links. This is the base to get to know organizational configuration and a starting point for planning and analysing information systems supporting company processes management (Abderrahmaneet al., 2014). Process model sallow tracing of relations among company organizational units and these schemes can be modified at any moment in dependence on changing conditions (Jiménez-Ramírezet al. 2015; Arunagiri, Ramachandran, 2015). Helquist et al., (2012) claims that virtual process simulation involves the creation of graphical models representing the process of interest and associated tasks. Graphical models representing the resources are also created. In general, company processes differ in

dependence on a character of innovation (Loarne-Lemaire, Maalaoui, 2015). Optimization of production and logistics processes is focuses on ineffective and incorrectly functioning processes (Samaranayake, 2015; Abu Rub, Issa, 2012). Their potential modification can concern processes structure, organization, allocation of human, technical, material and financial sources or a process course change (Řepa, 2012; Lübbeckeet al., 2015). The fact that after each process optimization it is necessary to update a company process model, while all the process changes must be recorded and communicated in the whole company should not be forgotten. The processes modified in this way can be automated. It is obvious that all the steps cause a lot of changes which in this connection can be marked as process innovations bringing a new state. They ensure working places optimization, increase of their performance, processes improvement and development of company production and logistics systems. Understanding the innovation process, the fact how innovation can be enhanced and how it can be measured present key steps to managing and enhancing innovation (Gambatese, Hallowell, 2011). According to Desouza et al. (2009) innovation is a crucial component of business strategy, but the process of innovation is difficult to manage and it requires a firm grasp of the innovation process. Spišáková (2008) claims, that processes innovations include new, respectively improved production methods, supply and distribution systems. According to Ritomský (2009) also changes in specific techniques, equipment or supply activities or safety risks determined to improved quality, effectiveness and flexibility of company activity can be included here. All the changes create the basis for informatization and digitalization presented by implementation of application program facility for company processes automation. Nowadays there a lot of companies providing customizable software solutions for processes automation. Samaranayake (2015) says that selection of a specific software application influences the performance of production and logistics processes. Hänel and Felden (2015) claim that its integration leads to processes higher efficiency and improvement. It is used as a way to change actually ineffectively functioning processes and enables companies working with a huge amount of data to obtain valuable information about company processes (Kabaale, Kituyi 2015; Suriadiet al., 2015; Grladinovićet al., 2007).

2. RESEARCH GOAL AND METHODOLOGY

The fact that process innovation presents a lot of changes necessary to be done before the introduction of software to support automation of production and logistics processes has already been mentioned. The phase of implementation as well as adaptation, however, bring further changes related to the whole company economy functioning. Since it is a radical intervention in a company, it is necessary to specify economic impacts on it closely. That is the reason why the paper concentrates on presentation of the results of empirical research whose goal was to analyse selected aspects of process innovations induced by implementation of automation of production and logistics processes. According to Balanced scorecard (BSC) their impact on a company economy is evaluated in four areas, specifically growth, financial, process and customer aimed at production processes automation. The data obtained in this way will serve as the base for formulation of conclusions and findings which bring closer the facts of their real impact in practice. For the needs of the research we focused on medium sized companies doing their business in Slovakia, which due to SK NACE Rev.2 classification belong to section C, i.e. industrial production. Based on data provided by the Statistic Office the group was made up of 980 companies. There were 186 respondents participating in the research.

3. RESULTS AND DISCUSSION

The first step is verification of representativeness of a sample set which is made by Pearson coefficient. The basic characteristic is a type of production formed by 24 so called divisions. To calculate the representativeness of this sample of companies the following formula is used:

$$\chi^2 = \sum_{i=1}^{m} \frac{(n_i - np_i)^2}{np_i} \qquad (1)$$

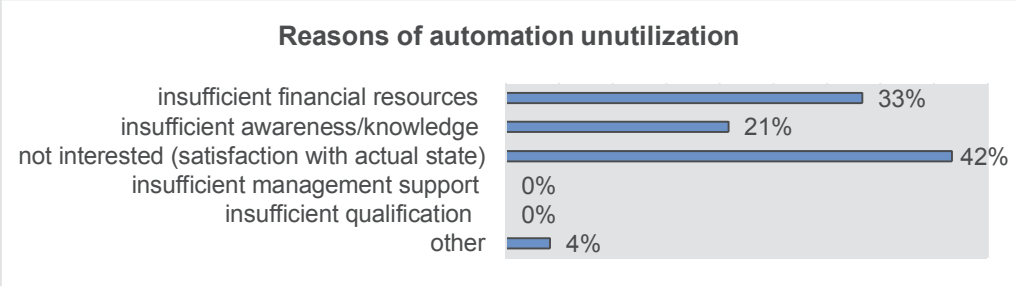
in which: n_i - real values; np_i - expected values. After substitution of real and expected values into the formula and by their calculation we get the size χ^2, which in our case was 0.976. The size of this value is compared to the result which presents the data from a statistical table where the degree of variance is 22 (23 signs - 1) and the significance level 0.05 (it means assumption of 95% probability of representativeness). This situation is expressed by the formula:

$$\chi^2_{1-\alpha}(k-1) \tag{2}$$

in which: α -significance level, (k - 1) - variance degree. The result is the value 33.924, and it applies here that if the value χ^2 is lower than a data from the statistical table the set is representative, and this applies also in our case. So if:

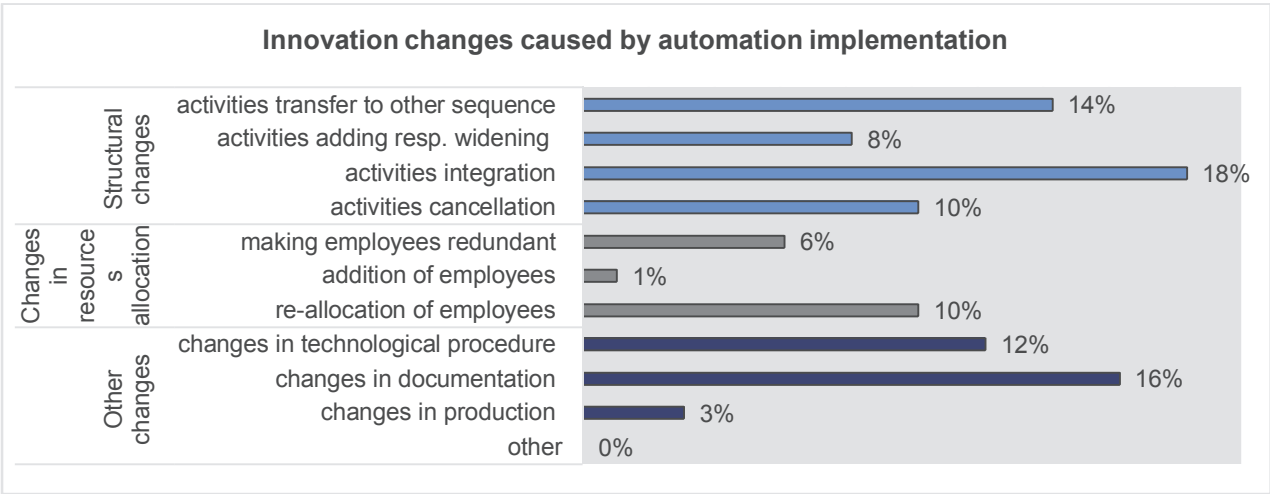
$$\chi^2 < \chi^2_{1-\alpha}(k-1) \tag{3}$$

it applies that the sample set is representative. Within the questionnaire survey we aimed at determination of the actual state of utilization of automation of production and logistics processes by the respondents. Out of the total number of 186 respondents up-to 114 - (61 %) of them pointed that the automation has already been implemented and 72 (39 %) say that these processed have not been automated yet. Based on these results we can conclude that most of medium sized companies already utilize automation of production and logistics processes. We found out the reasons of absence of processes automation provided by the respondents. Their opinions are presented in **Graph 1**.



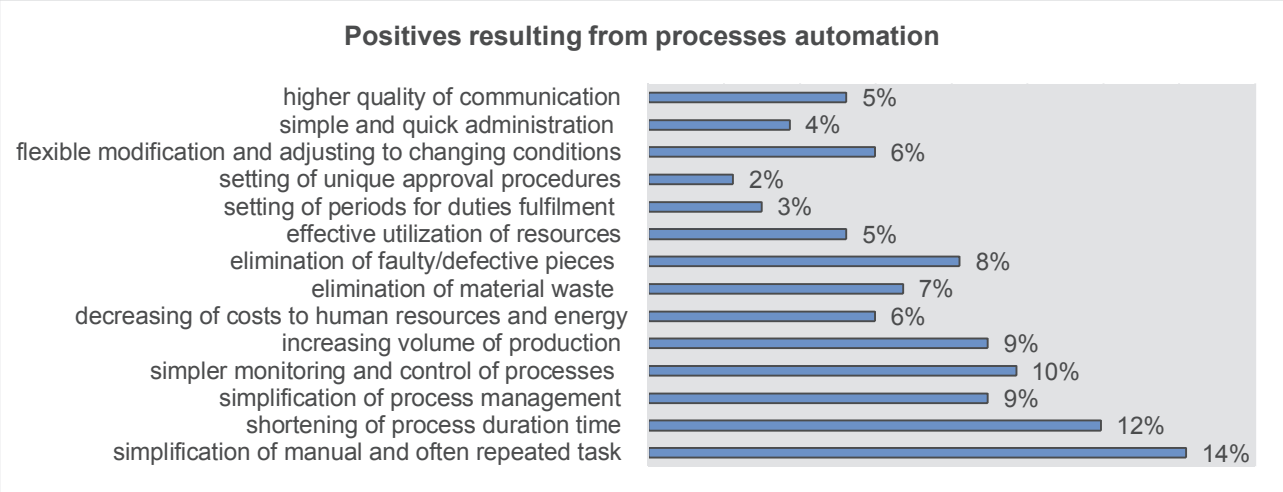
Graph1 Reasons of absence of processes automation in selected companies

Among the other options the respondents included the necessity to execute a lot of changes, unsuitability of implementation due to the subject of business and impossibility of complex accreditation. Analysis of an actual state of utilized information and communication technologies (ICT) in selected companies was aimed at determination of the fact if medium sized production companies dispose with informatization supporting automation of production and logistics processes.

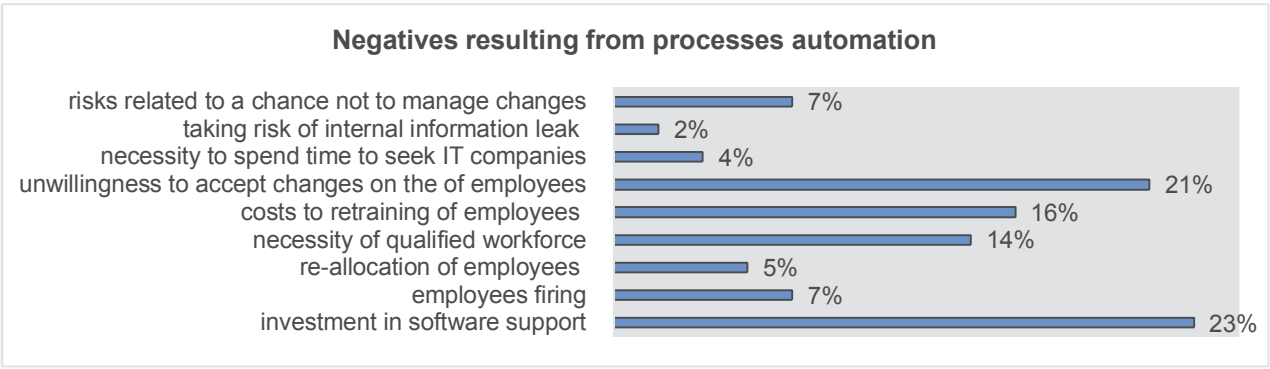


Graph 2 Summary of innovation changes after main processes automation implementation

Out of the total number of the respondents, 71 % - based on the results of the process audit - had to modify actually utilized ICT, since it was proved that it is not sufficiently adapted to implementation of software support to automatize production and logistics processes. Only 29 % of them achieved positive results based on which they could immediately start with software implantation without necessary modification of the actual ICT. The survey of changes related to automation of production and logistics processes, so called process innovation is introduced in **Graph 2**. 51 % of these changes are changes concerning the structure of activities, 17 % are related to human resources allocation and 32 % are presented by other changes. Their precise determination is shown in the graph. Since there are a lot of factors which affect a company whether positively or negatively, one of the researched areas was to specify closely a number of advantages and disadvantages connected with implementation of processes automation shown in **Graphs 3 and 4**.



Graph 3 Positives related to production and logistics processes automation

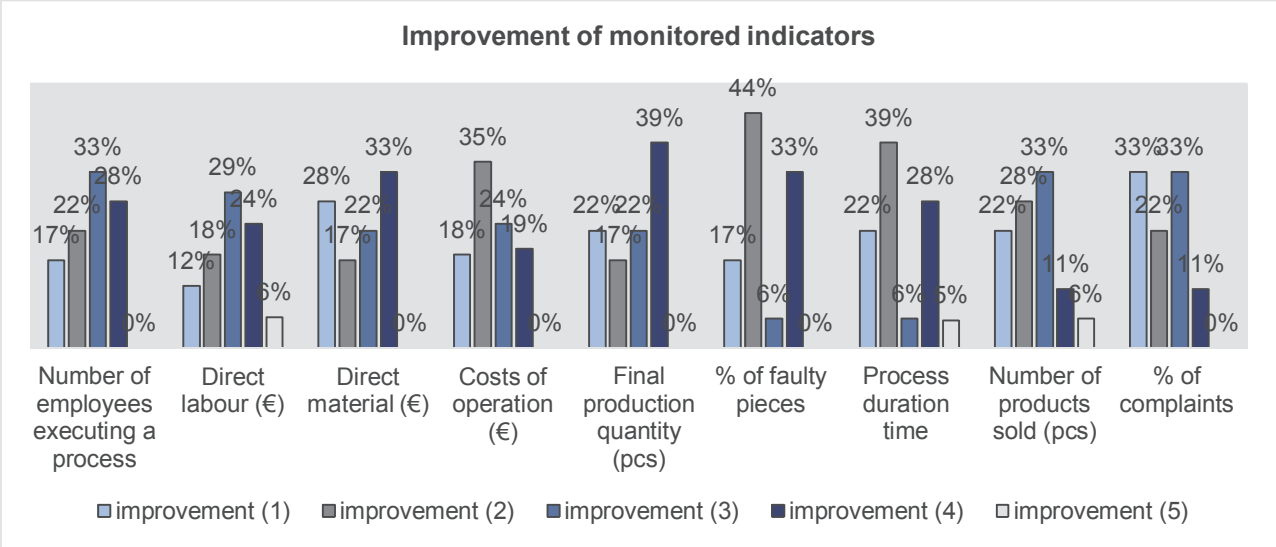


Graph 4 Negatives related to production and logistics processes automation

Table 1 Selection of indicators representing individual areas due to BSC

Indicator	Perspective due to BSC
Number of employees executing a process	growth
Labour costs for employees executing the process (direct labour in v €)	
Direct material (€)	financial
Costs of operation (€)	
Final production quantity (pcs)	process
% of faulty pieces (out of the total number of outputs)	
Process duration time	
Number of products sold (pcs)	customer
% of complaints	

The next step is selection of economic indicators by which improvement or decline of economic situation after implementation of processes automation aimed at production process is monitored. Individual areas indicators - due to BSC method - are shown in **Table 1**. In this way the companies by using the scale from 1 to 5 assessed the size of change in comparison to the state before automation implementation. Since only 65% out of the all respondents claimed that they have already automated production process, the following results related to these companies. The results are presented in **Graph 5**.



Graph5 Improvement of indicators after production process automation implementation

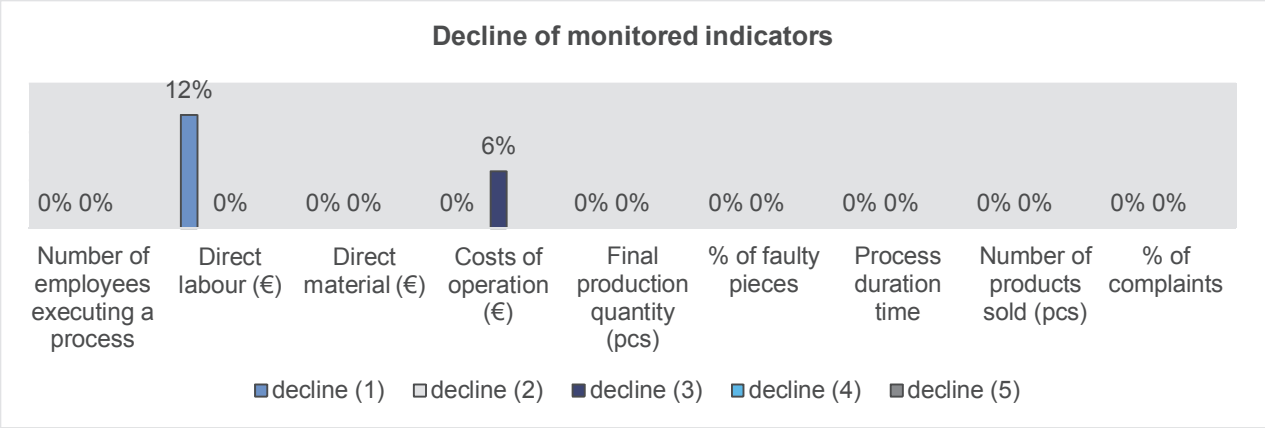
Up to 98% of respondents whose production processes are already automated provided their responses related to improvement of selected indicators. Each indicator was monitored individually that is why percentage expression of each of them is equal to 100 %, presenting the total number of respondents per 1 indicator. It can be seen from the graph that monitored indicators achieved different percentage share at different level of the evaluation scale. In evaluation two main criteria will be used, percentage representation of respondents and evaluation scale which stands for the size or importance of change in comparison to the state before implementation of production process automation. In both cases three indicators which achieved the best results will be determined. In case of the second criteria only the indicators which achieved evaluation at the level 4 will be determined, since in the case of the level 5 (expressing the greatest change) only few respondents provided their opinions. The data acquired in this way are consequently evaluated also for four selected areas (growth, financial, process and customer). **Table 2** briefly summarizes the results we obtained.

Table 2 Evaluation of indicators due to selected criteria

Criteria	Indicator		
Representation of respondents (%)	Percentage of deformities/faulty pieces (44)	Process duration time (39)	Fin. production quantity (39)
Evaluation scale (value)	Percentage of deformities/faulty pieces (4)	Direct material (4)	Fin. production quantity (4)

In two cases there are two identical indicators in the table, and they are considered as the most positive ones in relation to the criteria we had selected. As to indicators - process duration time and direct material - it can be said that the first one achieved higher percentage representation but only for level 2, but if we look at this indicator from the point of view of the monitored value 4, the first indicator achieved 28% representativeness and the second one up-to 33%. So also in this case the indicator direct material achieves the better result. As

well as in a case of the first indicator the respondents mentioned the change at level 2 and for the second indicator at level 4. Based on it we can state better results for a direct material indicator. After evaluation of data for individual company areas we conclude that changes were seen especially in the process area which is presented by three out of selected indicators, particularly percentage of faulty pieces and final production quantity in both criteria, but identically also in financial area by means of the direct material indicator. So the changes are mostly visible in company process area.



Graph 6 Decline of indicators after production process automation implementation

As to negative impact, only 2% of research respondents mention decline in relation to implementation of production process automation. Clear minor representation in comparison to the previous graph is seen in the Graph 6. Indicators direct labour and costs of operation recorded worsening. But in case of the first mentioned indicator its importance is expressed only by value 1 in the evaluation scale and it presents the least important change and in case of the second indicator it is expressed by value 3, i.e. decline of the indicator at approximately average or medium level.

4. RESULTS SUMMARY (CONCLUSION)

Based on acquired data we can conclude that most Slovak medium sized companies (61%) already utilize production and logistics processes automation. The companies which do not use process automation (39 %) mentioned the following main reasons of this situation: satisfaction with the actual state, insufficient amount of financial resources, insufficient awareness of this issue, and among the other reasons they named a necessity to make a lot of changes, unsuitability of implementation due to the subject of enterprise and impossibility of complex accreditation. It results from the actual sate of IKT in selected companies that 71% of them had to modify actually utilized IKT before the implementation of production and logistics processes. Only 29% of companies could implement software directly without a necessary modification of actual IKT. In relation to process innovations which are connected with process automation implementation our conclusion is that most changes concerned structural activities, lower percentage of changes was made of so called other changes, such as changes in technological procedure, documentation or production and the lowest percentage of changes concerned human resources allocation. Process of implementation of production and logistics processes automation brings lots of positive and negative impacts. According to the results of the questionnaire survey most companies claimed that simplification of execution of manual and often repeated tasks, shortening a process duration time, and its simpler monitoring and control are considered as the biggest positive impacts. As to negative impacts, most companies see them in connection with the necessity of initial investment in software support, unwillingness to accept changes on the part of employees and higher costs for their retraining. When reviewing improvements respectively decline of indicators which we had chosen after implementation of automation related to a production process, we concluded that most positively perceived indicators are a percentage of faulty products, since up to 44 % respondents expressed a change in this

indicator and in the level 4 which was monitored it achieved identical percentage representation (33 %). The second indicator is direct material, which at level 4 recorded positive evaluation by 33 % of respondents. And the indicator quantity of final production achieved evaluation 4 which represents up to 39 % of respondents. 2 % of respondents said that they also saw decline but only in case of 2 indicators - direct labours and costs of operation. Expression of their size in comparison to previous state, i.e. before implementation of automation achieved in case of first indicator the value 1 and in case of the second indicator its vale was equal 3. The results do not present marked decline. The results indicate that if companies want to become more flexible and more competitive, innovative solution having a form of utilization of application program facilities for automation and management of production and logistics processes seems to be the instrument how to achieve required state. Each company has to be aware of its financial, material and capacity possibilities. If a company possibilities are restricted this change does not have bring success automatically. It requires not only investments but also professional knowledge and skills which present supporting pillars for successful integration and management of all process changes, which are perceived not only as a starting point for informatization, digitalization and automation itself but are also related to the phase of adaptation for these changes.

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