INNOVATION AND LEAN PRODUCTION

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Abstract

VANĚČEK DRAHOŠ, PECH MARTIN, ROST MICHAEL. 2018. Innovation and Lean Production. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 66(2): 595–603.

Production has undergone historically through different changes, the essence of which is innovation. Innovations are either the introduction of new and more powerful machines and technologies, or just tiny, but everyday changes called Kaizen. The article focuses on the implementation of this second group of rationalization changes. 90 enterprises were surveyed and the results were evaluated mainly in terms of their size (small, medium, large), industry (engineering, electro-technical production, production of food, production of products for domestic use), and ownership of the company and by the importance in the supply chain.
Regardless their size, the enterprises expect to continue the current trend with increasing demand and therefore they expect to expand the production employing more workers. New technology is supposed to be implemented to a lesser extent, but the situation is significantly better for the enterprises with a foreign owner. In small enterprises there is usually the absence of standards, which is a prerequisite for successful planning. Tailor-made production according to individual customer requirements exists mostly in greater enterprises. Regarding different types of waste reduction, defects are reported to be the most important issue, followed by motion, over-production and waiting. The research of 90 enterprises shoved, that most of them are not getting ready in a particular way for the future, although it might not be as favourable as it is now. Enterprises should increase the share of products with higher added value.

Keywords: innovation, planning, lean production, standardization, kaizen, MUDA

INTRODUCTION

Innovation means a quantitative or qualitative change (preferably both together), allowing further development of the subject in the area, most often in production. They may take the form of a tangible (new or improved machine, production line) or intangible (a better way of organizing) assets. As Vlček (2011) notices, there is no clear-cut definition. He classifies four different types of innovation: product, process, marketing and organizational innovation. The paper focuses on the fourth group as mentioned above – organizational innovation. Innovations have begun since the very beginning of industrial production.

The history of innovations in industry states Vaněček *et al.* (2010). At the beginning of the 20th century, F. W. Taylor presented a methodology of time measurement and standardization, allowing planning of production and motivation of workers by means of task wages. H. Ford later introduces assembly-line production, requiring detailed tracking of individual movements of the workforce in the line using special methods. The Hawthorn studies of 1920–30's pointed out the need to monitor relations between workers, which Maslow later followed up with his theory of motivation.

The period between the two world wars in the Czechoslovak Republic focused on the use of partial methods to obtain a better effect, known as rationalization. In the period of "socialism" in the Czechoslovak Socialist Republic, efforts were made to introduce complex socialist rationalization, which gradually took over the methods commonly used in Western countries. After the Second World

War Toyota, Japan introduced a new approach of improving production, based on the day-to-day introduction of minor improvements, which would provide a greater effect together than if used separately. Such approach is known as Kaizen, and it was followed by lean production.

The goal of lean manufacturing is to produce more with less resources (Krafcik, 1988; Womack *et al.*, 1990; Womack and Jones, 1994; Jasti and Kodali, 2015). It uses virtually all known methods, of course, depending on how they work for each workplace. Lean production is mainly focused on simpler and less demanding measures, not requiring demanding investments, but these measures must be pursued continuously, every day.

The paper discusses the methods of lean production and their use in enterprises. Such innovation may be introduced in every single enterprise, regardless its size.

Literature Review

Enterprises go through their own development since their establishment until their end, and they are also strongly influenced by the social environment, which is also undergoing substantial changes. In the Czech Republic, the economy was planned for 40 years, and then the era of a developed market economy started. Now there are other changes related to new technologies, called Industry 4.0. Each of these historical periods requires the enterprises to use slightly different methods to meet their goals. These methods also include methods of rationalization, i.e. improvement of the current situation.

Leščišin (1985) classifies the methods of rationalization as general and specific. The specific methods include time and movement studies, graphical, mathematical, and statistical methods, etc. These methods are based on theoretical knowledge, mostly suitable for senior and middle management. In general, it is still possible to apply these methods today. However, they are still being supplemented by others, many of which are "tailor-made" to the production workers, so that they can also participate in the innovation effort. It is, for example, the Kaizen aggregate method, i.e. continuous improvement, general to partial improvement methods that concern both managers and staff. Other types include the methods of improving the maintenance of the means of production, Just-in-time, Kanban and others, but also the PDCA cycle, the innovation movement, and robotics. IMAI (2001) reports that Kaizen pays great attention to the innovation movement. Similarly, other authors characterize Kaizen, too (Keřkovský and Valsa, 2012). The comprehensive review of recent notion of continuous improvement (Kaizen) was analyzed by IWAO (2017), who described Kaizen from an innovation perspective as a gathering of similarly small, mutually independent, incremental innovation processes carried out by workers, working teams, and their leaders. Hammer and Champy

(1993), on the other hand, introduced a fundamental rethinking and radical change in the business processes. According to Gunasekaran and Kobu (2002), business process reengineering (BPR) concerns a dramatic and sustained improvement in quality, cost, service, lead time, flexibility and innovation.

However, a new period has occurred, known as the Fourth Industrial Revolution, characterized primarily by digitization, robotics and artificial intelligence. Recent innovations are based on the Industry 4.0 applications such as three-dimensional (3D) printing (Sun and Zhao, 2017), Internet of Things (Gubbi *et al.*, 2013), robotics (Fong *et al.*, 2003), augmented reality (Azuma *et al.*, 2001), smart technologies etc. According to Brunn and Mefford (2004) almost every company and business activity has been affected by the Internet in the last few years and whole new industries have arisen because of this technology. It is obvious that the innovation methods must change, focusing on replacing simple, repetitive tasks with robots. Improvements will not only concern the current production, but the entire value chain, from the development of new products, through production, to recycling at the end of their life. The focus of improvement methods will shift from simple ideas of the workers towards higher levels of management and the ability of the workers to anticipate future developments and respond quickly to the changes (Mařík *et al.* 2016).

MATERIALS AND METHODS

The aim of the research was to find out the differences in the use of the main lean production methods according to the size, specialization and owner of the enterprise and to recommend which methods should be targeted primarily by enterprises. Individual sophisticated production methods were grouped into the following categories: development trends, forecasting planning and methods, tailor-made standardization and production, loss detection and loss reduction.

The research is based on 90 questionnaires, which were filled in with the managers by the students of the University of South Bohemia in České Budějovice, Faculty of Economics in 2016. The questionnaires classify the following categories:
- By the industry (business) of enterprises into: 1. engineering, 2. electro-technical production (electrical industry), 3. production of food 4. production of products for domestic use;
- by size (number of employees) into 1. small enterprises (up to 49 workers), 2. medium-sized enterprises (50–249 workers) and 3. large enterprises (over 250 workers);
- by the owner (a part of a foreign enterprise or not)
- by the importance (whether an enterprise is considered a key or dependent article) in the supply chain.

The questionnaires were first analysed by enterprise size and business specialization. Since there were only 4 businesses in the "electrical industry", we do not list them as a separate item in the tables, but they are counted in sets classified by enterprise size, ownership, and supply chain. Classification by ownership relations and by the importance was complementary to see if these factors significantly influence manager decisions. In the paper, the distribution by importance in the supply chain is not further analyzed, as no significant differences were found.

The percentage shown in the tables is always calculated from the number of enterprises in a line. If there is more than one answer to one question, it exceeds the sum of 100%.

The results obtained were then subjected to statistical analysis by individual tests of equal and given proportions without correlation to continuity. In particular, statistical hypotheses were formulated for each category of slim production methods:

H0: The null hypothesis is that the observed phenomenon have the same proportion

HA: The statistical alternative hypothesis is that this proportion is different in at least one case.

In the case of multiple comparisons of relative frequencies, Holm's method of adjusting the level of significance reached was used. The results are interpreted at alpha significance level = 0.05, resp. with 95% reliability. For reasons of clarity, only significant results, including achieved level of significance (p-value), are given in the text. Statistical evaluation of individual tests was performed using R 3.3.3 programming environment.

RESULTS AND DISCUSSION

Development trends

Tab. I shows the questions that are significantly different for different groups of enterprises. The enterprises expect to: 1. expand the production (d); 2. increase the workforce (e); 3. introduce robots to some workplaces (f); 4. scale up robots (g); 5. expand customer service h) 6. use 3D prints for some products (i).

Regarding the expected trends, the differences between enterprises were determined by three criteria (size, specialization and ownership). The following working hypothesis was formulated:

H1: The enterprises are different in expectation of future development trends.

a) By size – REJECTED

Expected trends in future developments are not statistically significant. The results are surprising, as the differences between small and large enterprises are not as significant as expected.

● 2/3-3/4 of all enterprises expect expansion of production
● Approximately 30-40% of the sample expect an increase in the number of workers in the future, but only an extensive expansion of production
● With the expansion of customer service, it accounts for about one third of the enterprises; the differences between the different categories are small.

Large enterprises mostly predict increase in production (d), the introduction of robots (f, g) and the use of 3D printers for certain types of products (i). Only the increase in the workforce is related to lower expectations of large enterprises. This may be caused by the assumption that the involvement of the robots will improve workforce use and labour productivity. The number of necessary workforce will be reduced. From the point of view of expanding customer service, the highest values are reported for the medium-sized enterprises, for which it can be a decisive competitive advantage in the future against large enterprises that focus on large-scale production.

b) by specialization – REJECTED

Classification of enterprises by specialization did not show any significant differences in the trends.

c) by ownership – (CONFIRMED for robot implementation only)

I: *Expected development trends (in %)*

No.	Category of enterprises	Number	Expected trends					
			1	2	3	4	5	6
a	b	c	d	e	f	g	h	i
1	Small	26	65.4	38.5	7.7	0.0	19.7	7.7
2	Medium-sized	34	73.5	38.2	20.6	2.9	35.2	8.8
3	Large	30	76.7	33.3	33.3	10.0	33.3	16.7
4	Engineering	45	71.1	35.6	28.9	6.7	33.3	15.6
5	Food	17	70.6	23.5	11.8	5.9	29.4	0.0
6	Household supplies	24	70.8	50.0	12.5	0.0	29.2	8.3
7	Owner foreign	35	72.3	40.0	28.6	**11.4**	31.4	17.1
8	Owner Czech	55	69.1	34.5	16.4	**0.0**	29.1	7.3

Explanatory note: the statistically significant differences at the significance level of 5% are marked in bold; the arrow indicates the trend of development.
Source: authors (2017)

The working hypothesis based on the owner was confirmed only in the case of robot use tendencies (column g, p-value = 0.04133). In other cases, developmental trends were not statistically proven.

Regarding the expectations, the enterprises with a foreign owner have higher expectations for all the monitored trends, but the differences were not significant. The use of 3D printing is expected by only 10-15%, which also fails to meet the prerequisites of the development of Czech production.

There is a similar trend in robot implementation. It is mostly expected by large enterprises with foreign owners. However, the expected percentage of robotization is low compared to the expectations.

Planning and forecasting methods

A plan should be the basic document of the business for its activities. Comparing the plan and reality allows you to make the necessary managerial interventions in time. Planning only gives answers to two crucial questions: Whether an enterprise compiles detailed schedules for days, weeks, or if it does not plan production (sales) at all during the year.

In terms of planning and demand forecasting methods, the working hypothesis was formulated as follows:

● H2: There are differences among the enterprises in the planning and use of forecasting methods.

a) by size (REJECTED for planning, CONFIRMED for demand forecasts).

Based on the statistics, it was not confirmed that the size of enterprises varies considerably in the way they are planned. Despite the statistics, it is obvious at first glance that detailed plans are compiled primarily by large (70%) and medium-sized enterprises, with small ones being considerably less. It is striking that a quarter of small and medium-sized businesses do not have a plan at all, the implementation and control of which should be the main task

of the management. Small and medium-sized enterprises without plans should set up at least simple plans for each month, allowing effective control and the adoption of appropriate measures in case of failure to comply with the plans.

In the case of differences in the use of forecasting methods, the working hypothesis was confirmed (columns f, g). The difference was found, both for statistical forecasts (p-value = 0.0007516) and prediction by estimation (p-value = 2.548.10⁻⁵).

The predictions by estimation were further analysed. The largest difference was found between the small and medium-sized enterprises (p-value = 0.00096) and small and large enterprises (p-value = 0.00048). Differences in prediction are especially for large enterprises that use statistical methods most often and less predictive for estimates. For small enterprises, this is primarily an estimation method based on experience, which seems to have good results here, especially when the manager works in the enterprise for a long time so that they can estimate the trends well.

b) by specialization (REJECTED for planning, CONFIRMED for demand forecasts

In terms of planning, the enterprises in all three sectors in the research are not statistically significant. It was found that planning for days and weeks is predominant in food industry businesses. However, this difference was not significant. The food industry is very specific, because it is heavily traded with daily consumption goods and the planning therefore corresponds to the speed of the stock changes.

Unlike production planning, the difference in the use of forecasting methods was found, both for statistical forecasts (p-value = 0.01851) and prediction by estimation (p-value = 0.03359). Predictions through statistical methods (p-value = 0.045) and estimate (p-value = 0.087)

II: *Planning and forecasting of demand (in %)*

Nr.	Category of enterprises	Number	Planning		Forecasting of demand	
			days, weeks	No plan	Statistic methods	Estimate only
a	b	c	d	e	f	g
1	Small	26	42.3	26.9	**3.8**	**80.8**
2	Medium-sized	34	61.8	23.5	**14.7**	**73.5**
3	Large	30	70.0	6.7	**43.3**	**26.7**
4	Engineering	45	55.6	8.9	**33.3**	**48.9**
5	Food	17	70.6	11.8	**17.6**	**70.6**
6	Household supplies	24	58.3	20.8	**4.2**	**79.2**
7	Owner foreign	35	**80.0**	5.7	28.6	**42.9**
8	Owner Czech	55	**45.5**	18.2	18.2	**70.9**

Explanatory note: the statistically significant differences at the significance level of 5% are marked in bold; the arrow indicates the trend of development.
Source: authors (2017)

differ significantly between the categories of engineering and households supplies.

c) by the owner (partly CONFIRMED)

The working hypothesis on the difference in the planning process between enterprises with foreign and Czech owners was confirmed (column d, p-value = 0.002467). The results also show that the absence of planning is more common for the enterprises with Czech owners. Foreign-owned enterprises are more committed to production forecasts, as they can use a certain managerial know-how of the parent company for the preparation of plans.

Regarding the difference in the use of estimation methods, the difference between enterprises with foreign and Czech owners (p-value = 0.0152) was found here. In the case of estimating demand through statistical methods, the differences were not confirmed.

Standardization and tailor-made production

Standardization is closely related to planning and efficient use of resources. Standards are created by enterprises in different forms (technical, technological, working, etc.).

Regarding standardization and the use of „tailored" production, the following working hypothesis was formulated:

- H3: There are differences in the use of standards and tailor-made production among the enterprises.

a) by size (CONFIRMED for production processes and tailor-made production)

The working hypothesis was confirmed only when standardization was used in production processes (column g, p-value = 0.02352). Otherwise, the use of standardization did not reject the statistical hypothesis. However, less attention is paid to the standards by small enterprises, which rely on easier production, tradition and management experience. Large businesses, in contrast to small ones, use standards to control the use of machine capacities and to comply with production processes. In medium-sized and large enterprises, standards are of great importance for staff remuneration and tailor-made production. Small businesses, compared to the other two categories, considerably less use standards for production planning and employee remuneration, probably due to easier production and fewer production sources. Different classification by a category show significant differences.

Based on the statistics, it was proved that the enterprise with a different number of workers do not differ significantly in the use of tailor-made production (p-value = 0.004187). There was a significant difference between small and medium-sized enterprises (p-value = 0.026). Tailor-made production is today a common requirement for enterprises and they need to adapt ti it flexibly. Most of the sample enterprises captured this trend, surprisingly only 42.3 % of small enterprises are able to do so. It is precisely for small enterprises, which often follow extended crafts production, that production according to individual customer requirements should not be a problem. Negatively, there seem to be a small number of technicians and foremen who would be able to quickly change the production as needed.

b) by specialization (CONFIRMED for tailor-made production)

There were no significant differences in the way of using standardization if classified by specialization. However, the importance of tailor-made standards was shown.

For tailor-made production, it was confirmed that the enterprises were significantly different (p-value = 0.000000028). The differences were particularly evident between the category of engineering and food production (p-value = 0.000015), and between engineering and households supplies production (p-value = 0.000063).

III: *Standardization and tailor-made production (in %)*

Nr.	Category	Number	Standards are mostly used for:				Tailor-made production
			Produc-tion plan	Remune-ration	Machinery	Production processes	
a	b	c	d	e	f	g	h
1	Small	26	34.6	15.4	15.4	**50.0**	**42.3**
2	Medium-sized	34	64.7	41.2	32.3	**50.0**	**76.5**
3	Large	30	60.0	36.7	43.3	**80.0**	**80.0**
4	Engineering	45	51.1	31.1	31.1	66.7	**91.1**
5	Food	17	64.7	23.5	29.4	64.7	**29.4**
6	Household supplies	24	54.2	37.5	25.0	54.2	**95.8**
7	Owner foreign	35	62.9	45.7	42.9	68.9	80.0
8	Owner Czech	55	50.9	25.5	23.6	60.0	81.8

Explanatory note: the statistically significant differences at the significance level of 5% are marked in bold; the arrow indicates the trend of development.
Source: authors (2017)

c) by the owner (REJECTED)

The Czech-owned enterprises use standards less in remuneration and machinery compared to a foreign owner. However, statistically, these differences were not significant because it was not possible to reject the statistical hypothesis on frequency matching.

Detecting and reducing waste

There are different types of waste in production, reducing its performance. That is why a number of methods, such as the Japanese method of classification, known as MUDA, deal with this issue. MUDA distinguishes 8 kinds of waste (1. Over-production; 2. Inventory; 3. Defects; 4. Motion; 5. Waste and scrap; 6. Waiting; 7. Transportation; 8. Skills)

The following hypothesis was formulated on waste reduction:

● H4: There are differences among the enterprises in the extent of waste detection and reduction.

a) by size (partly CONFIRMED)

The hypothesis was confirmed for waste of inventory (p-value = 0.01851), motion (p-value = 0.0209), waiting (p-value = 0.02752) and transportation (p-value = 0.01525). The difference was significant for motion, mostly between small and large enterprises (p-value 0.042). In transportation, the difference is huge in particular between small and large enterprises (p-value = 0.041).

Some types of waste are increased from small to large enterprises – inventory, motion, waste and scrap, waiting and transportation. Waste due to misuse of skills (column 8) are reported as minor. The greatest waste was reported by engineering enterprises. In such case it might be seen as a lack of qualified workers. There is a relatively high number of enterprises showing overproduction losses, which is particularly problematic for large enterprises of mass production.

b) by specialization (CONFIRMED for over-production and defects)

The hypothesis was confirmed for defects (p-value = 0.005321) and over-production (p-value = 0.02459). This means that the enterprises are statistically different. In comparison using a pair test, there are differences between engineering and food production in over-production (p-value = 0.013) and defects (p-value = 0.045). In other cases, it was not possible to reject the statistical hypothesis by different specialization. Waste of over-production and transport are mainly for food businesses.

c) by owner (partly CONFIRMED)

The hypothesis was only confirmed in case of motion waste (p-value = 0.01555) and waste and scrap (p-value = 0.01975). In other cases, it was not possible to reject the statistical hypothesis by the owner. The enterprises with a foreign owner reported a higher percentage of waste in most of the categories monitored. It can be assumed that this is the result of a more critical view of waste, compared to Czech enterprises.

DISCUSSION

The essence and expectations of future trends in the long term according to SCHÖNSLEBEN, FONTANA and DUCHI (2017) relates to the degree of success in establishing common standards for technologies that can connect factories or implementation of the Industry 4.0. In our research, we focus on some of the benefits of these new trends, especially the expansion of the production. The origin of production expansion is related to economic growth. Our research works with

IV: *Waste in the enterprises (%)*

| Nr. | Category | Number | Range of MUDA wastes in enterprises |
			1 Over-production	2.Inventory	3. Defects	4. Motion	5. Waste and scrap	6. Waiting	7. Trans-portation	8. Skills
a	b	c	d	e	f	g	h	i	j	k
1	Small	26	38.5	**19.2**	42.3	**0.0**	42.3	**23.0**	**26.9**	15.4
2	Medium-sized	34	14.7	**52.9**	52.9	**20.6**	47.0	**26.8**	**20.6**	5.9
3	Large	30	33.3	**50.0**	56.7	**26.7**	56.7	**53.3**	**53.3**	20.0
4	Engineering	45	17.8	46.7	**62.2**	26.7	51.1	42.3	28.9	20.0
5	Food	17	58.8	47.1	**23.5**	5.9	41.2	17.6	41.2	5.9
6	Household supplies	24	15.0	33.3	**50.0**	12.5	51.2	29.2	33.3	4.2
7	Owner Czech	35	25.7	54.3	57.1	**31.4**	**65.7**	45.7	42.9	17.1
8	Owner foreign	55	29.1	36.4	47.3	**9.1**	**38.2**	27.3	25.5	10.9

Explanatory note: the statistically significant differences at the significance level of 5 % are marked in bold; the arrow indicates the trend of development.
Source: authors (2017)

two scenarios. Firstly, economic growth occurs as a result of the development of human capital (Becker *et al.*, 1990) and therefore more workforce or the expansion of customer services will be needed. The second scenario relates to the technologies such as robotics, 3D printers etc. and their application in manufacturing. The research results show the differences in expected trends among enterprises in the case of robotics. These results were significant in enterprises divided according to their owner only. Future developments based on the introduction of robots are expected mainly in companies with a foreign owner (from other countries). This result can be explained by the close connection of the Czech Republic to the European market (especially to Germany). According to the International Federation of Robotics (IFR) the average global robot density is about 75 industrial robots installed per 10,000 employees in the manufacturing industry in 2016. The most automated countries in the world are the Republic of Korea, Singapore, Germany and Japan. The most of these robots are used in automotive and electrical/electronics industry (Statista, 2016). Durakbasa et al. (2016) states that the challenge today is implementing the concepts automation creatively with the possibilities of new sensors not only in large production complexes but mainly in small and medium-sized enterprises (SMEs). The critical factors in adopting industrial robots in SMEs are flexibility and cost. Large companies have more resources to implement new technologies than SMEs. The result of our research also showed that enterprises in the Czech Republic (regardless of their size and specialization) are still considering new trends.

The results of the research further suggest that there are significant differences in the use of forecasting methods classified by size and specialization of the enterprises. According to Stadtler and Kilger (2010) planning demand usually represents a series of activities that are repeated monthly and lead to an update of demand forecasts. The highest usage of forecasting methods (including statistics methods) are found in the large enterprises and engineering companies, which challenge the demanding requirements of the customers. The enterprise has to cope with strong oscillations in sales by means of operational increase of production and labour capacities especially in manufacturing sector. Key aspects to cope with these developments are the planning horizon as well as the improvement of the planning quality. Large enterprises actively use digital planning tools (for example SAP, ERP etc.), but many small and medium enterprises (SMEs) have not yet used them (Bracht *et al.*, 2011).

Through the trend of globalization and cooperation with large enterprises and supply chains, SMEs are forced to adapt a digital solution. The results show that companies with Czech owners are still rather using only demand estimates.

Lean manufacturing has widely been executed in large scale industries over the last decades. We find that large enterprises in contrast to small ones use standards to manage production processes. The process of problem modelling and evaluation of production efficiency requires know-how and high level of production systems. SMEs often do not have the time, personnel, information or resources to engage in standardization. Moreover, SMEs regard the standardization process as being inflexible (Blind and Thum, 2004). EU-SME Observatory Research (European Commission, 2002) identified difficulties experienced by SMEs in applying standards correctly, obtaining certification, lack of information and the inability to participate in the development of new standards. The required flexibility can also be achieved by tailor-made production. Results of our research show differences between enterprises based on their size and specialization. Production is probably less tailored to the customer needs in smaller companies due to narrower product portfolio and less resources to adapt production. Less tailored production imply results obtained in the food industry. Patak and Vlčková (2012) states that according to company managers, the end-customers in the Czech markets of the food industry are trained to buy cheap goods. Therefore the most efficient production focus in retail is the price.

Finally, the research focused on the detecting and reducing of waste based on the MUDA method. The results of our research suggest that there are significant differences in four out of eight kinds of MUDA wastes, if the enterprises are classified by their size. These four wastes are associated with inventory, motion, waiting time and transportation. The results could be compared with Antosz and Stadnicka (2017) study. In this study the main wastes which SMEs want to eliminate using the lean philosophy are waiting for material, unnecessary movements, machine failures and nonconforming products (defects). Some of these wastes are commonly preferred (such as waste and scrap, defects and over-production) regardless on the enterprise size. Our research provides a useful insight into the differences between these kinds of wastes. Further research can provide more information about the causes of these wastes and the differences between different types of enterprises.

CONCLUSION

Current situation is being complicated for the enterprises. In the long term, there are technical and technological changes, referred to as Industry 4.0, which are not just a quantitative continuation of the current development, but a particular new situation, requiring the enterprises to invest in new

technologies and management, flexibility and willingness to accept and implement the changes. In spite of the expected changes, the application of proven and traditional principles and management methods is related to many benefits that require almost no investment. Some of these principles were examined on a sample of 90 enterprises to find out the extent of their application.

The research did not reveal any differences in the expected future trends of enterprises (H1) according to their size and specialization. Divided into the enterprises with a foreign or Czech owner, the difference in development trends on a larger scale was recorded with the introduction of robots only. Regardless their size, the enterprises expect to continue the current trend with increasing demand and therefore they expect to expand the production employing more workers. New technology, such as robotization, 3D print, is supposed to be implemented to a lesser extent. The situation is similar both in small and large enterprises. However, in large enterprises, this low interest in progress can be explained by the fact that the changes are planned by the top-management and management levels or other employees do not know about it.

The effective work of each business must be based on the objectives set out in the business plans (verification by H2). Here is a large gap in small enterprise of up to 49 employees, because a quarter of them have no working plan at all. The situation is significantly better for the enterprises with a foreign owner. By comparing the results by size and specialization, the differences between enterprises were not confirmed in planning but they are statistically significant in the use of demand forecasts. Regarding the differences in the enterprises with foreign participation and the Czech owner, the difference was found in planning and demand forecasting methods only for days, weeks and estimates.

A prerequisite for successful planning is also the use of different types of standards (H3), allowing a precise formulation of partial intentions. This is also reflected in the absence of standards and overall standardization in a large number of small enterprises. In terms of enterprise size, differences in the application of standards were confirmed by manufacturing processes. Tailor-made production according to individual customer requirements is found to be fairly high for all enterprises, but least for small enterprises.

Regarding different types of waste reduction (H4), defects are reported to be the most important issue, followed by motion, over-production and waiting. Larger significance is attributed to such waste by enterprises with a larger number of employees. The statistical confirmation in terms of enterprise size was found for waste caused by inventory, motion, waiting and transportation. By comparison by specialization, differences were found only for waste caused by over-production and defects. Regarding the ownership of the enterprise, there was a difference between waste due to unnecessary motion, waste and scrap.

The research of 90 enterprises showed that the enterprise expect the current trend of both Czech and global economy to be followed in the future. The enterprises are not getting ready in a particular way for the future, although it might not be as favourable as it is now. However, it is necessary to abandon the current trend, according to which Czech enterprise are mainly referred to as "assembly plant" using pre-fabricated parts. They should prefer to increase the share of products with higher added value, which can be better sold on the market, even in the times of the economic crisis.

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