

METHODS OF LEAN PRODUCTION TO IMPROVE QUALITY IN MANUFACTURING

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Quality in manufacturing can be improved by using lean production methods. The paper discusses traditional and modern methods of lean production and their use in different enterprises.

Through a questionnaire survey and research, 90 industrial enterprises were classified by the size, production scope and their ownership. The research results were analyzed by means of statistical methods to determine the differences in the use of lean production methods.

Regarding the lean production and its different methods, the size of the enterprise is an important factor. The statistics revealed that large enterprises tend to use lean production more. Moreover, some methods are quite new to the majority of the enterprises.

Some questionnaire surveys conducted in different countries (especially in the US) use a different enterprise size classification. As the research results show, there is still a large potential for the introduction of lean production methods in small and middle-sized enterprises that can help enterprises to improve the quality of their production.

The application of lean production methods has been investigated so far, especially in large engineering enterprises. The paper deals with the use of these methods also in small and medium sized enterprises. The authors focused their research also on non-engineering enterprises in the field of the food industry and production of products for domestic use too.

Management of production went through a lot of changes in the past. At first, there are the methods used mostly in the first half of the 20th century at the time of mass production development. Such methods were promoted by Frederick W. Taylor, Henry Ford and others. Their aim was to cut the production time out, by using performance standards, assembly lines and similar methods. The methods were created by the top management, promoted from the top to the bottom as the factory workers were neither educated nor motivated enough to support the initiative. The state changed after the Second World War when the market of the producer was replaced by the market of the customer, much more demanding in

Suddenly, it was impossible to ensure the requirements from the top only. It became necessary to engage the workers into the process. Instead of engaging their physical strength only, it was necessary to add their brain, abilities, and initiative. At first, such requirements were applied in Toyota, a Japanese automotive company. After the influence of the requirements on competitiveness increase was proved, the methods started to be popular in other companies.

The paper deals with using different methods of lean production, considering their acceptability. It discussed if the enterprises prefer traditional methods or if they try to use the new methods too. The aim is to suggest possible methods, which are not so common, but useful for small and middle-sized enterprises. The methods of lean production are partial tools, useful under particular conditions, such as mass production, single-piece production, for enterprises with high/low number of employees etc. The system of lean production methods is not

strictly limited; there are new methods applied if they better suit to new technology of production.

The students of the University of South Bohemia in České Budějovice, the Faculty of Economics, were able to obtain ninety questionnaires dealing with applying lean production in the enterprises, in 2016. The questionnaires are classified into the following categories:

- By the industry of enterprises into:
 1. engineering,
 2. electro-technical production,
 3. food industry, 4. production of products for domestic use;
- by size (according to the 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. Since there were only 4 businesses in the “electro-technical”, 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. In the paper, the distribution by importance in the supply chain is not further analysed.

Using the method of lean production is not an end in itself. It should take the targets as set by the enterprise and possible future trends as the starting point. The present might be seen as a turning point of a quick development of new technology (known as Industry 4.0) due to which there might be a change in applying digitization, robotization and artificial intelligence in a short-time period of 10 to 15 years. The communities of experts have become familiar with such trend. The question, however, is whether the enterprises are ready for the future development. It is possible to predict that in spite of possible changes in technology, the current methods of lean production will be used as long as the current production procedure is used. The results of the research are divided into the traditional and new methods.

The traditional methods in our results include such methods that have been known since half of last century: Just-in-Time (JIT) followed by Kanban, ABC method related to both suppliers and customers, and continuous improvement processes (CIP).

Table 1 – Traditional Methods of Production Improvement (%) (Author’s Own Work)

Categories of Companies	Number	JIT is Used	Kanban is Used	ABC for Suppliers	ABC for Customer	CIP
Small	26	19.23	3	34	38	11
Middle-sized	34	17.65	8	44	52	35
Large	30	23.33	46	70	53	63
Engineering	45	20.00	33	60	48	51
Food industry	17	35.29	17	41	58	11
Household supplies	24	16.67	0	33	41	29
Foreign owner	35	22.86	34	57	51	60

Tab. 1 summarizes the use of methods in enterprises. The percentage for each method shown in the table is always calculated from the number of enterprises in column "Number". The statistically significant differences at the significance level of 5% are marked in bold.

Regarding the using of five traditional methods, the differences between enterprises were determined by three criteria (size, specialization and ownership). The following working hypothesis was formulated:

H1: The enterprises differ in using traditional methods of improving production.

•By size – CONFIRMED (for Kanban, ABC used for suppliers, and continuous improvement)

Based on the statistics, it was proved that the enterprises differ in three (out of five) traditional methods. The statistically significant difference was found in the Kanban method (p-value = $4.05 \cdot 10^{-5}$), especially between the large and small enterprises (p-value = 0.0028), and the large and medium-sized enterprises (p-value = 0.0034). The differences in enterprise size were further significant in the supplier-centred ABC (p-value = 0.020). In the case of the CIP, the differences are also statistically significant (p-value = 0.0003289), in the case of small and large enterprises (p-value = 0.00069). No significant differences were found for other traditional methods classified by the size of enterprises.

•By specialization – CONFIRMED (for Kanban, and continuous improvement)

Using the traditional methods, the enterprises are different in Kanban (p-value = 0.004876) and continuous improvement (p-value = 0.01058) only. Regarding the Kanban method, the significant differences were found comparing engineering enterprises and household supplies producers (p-value = 0.012). Using continuous improvement is far superior in engineering enterprises compared to food industry (p-value = 0.034). No significant differences were found for other traditional methods classified by the scope of enterprises.

•By ownership – CONFIRMED (for Kanban, and continuous improvement) Similarly to specialization, the working hypothesis was proved for Kanban (p-value = 0.01499) and continuous improvement (p-value = 0.001171). No significant differences were found for other traditional methods classified by the owner of enterprises.

Further, the paper will focus on traditional methods where the statistically significant differences are highlighted in the tables.

Just-in-Time and Kanban

The Just-in-Time method was developed and successfully applied in Japan in the 1970s. The basic prerequisite is delivery of the necessary items only, in the necessary quantities, the correct quality and at the latest allowable times. This reduces inventory and production and reduces storage space.

Kanban is a self-regulatory production control system. It is a label (card) that fulfils the function of the order. Individual workplaces order with the same Kanban cards the same, limited amount of items that correspond to the permitted level of inventory of finished parts and products. Kanban is part of the Just-in-Time method. The questionnaires revealed that Just-in-Time method is only applied partially in enterprises, mostly in large enterprises. Although it was created for the needs of the automotive industry, it has approximately the same application in food industry and household supply production.

Table 2 – Five New Methods of Production Improvement (%) (Author's Own Work)

Categories of Companies	Number	5S	TPM	VSM	EDI	CAM
Small	26	11	11	15	30	23
Middle-sized	34	26	32	41	35	29
Large	30	46	43	43	56	3
Engineering	45	35	35	44	42	22
Food industry	17	23	23	23	58	17
Household supplies	24	20	25	20	33	20
Foreign owner	35	42	42	48	48	23

The size of enterprises is very important factor in implementing and using the methods of lean production. The use of both traditional and new methods increases towards large enterprises. There are significant differences between different sizes confirmed for three traditional and new methods out of five. The results for both groups are rather similar. It means that the enterprises prefer neither the traditional nor the new methods of production improvement.

Regarding the specialization, it was confirmed that the enterprises generally prefer the traditional methods to the new ones. In particular, engineering is active in implementing new methods, followed by the food industry and household supply production, using EDI and computer-aided management a lot. Regarding traditional methods, a less interest in Just-in-Time is noticeable, together with the considerable use of ABC method and focus on continuous improvement in engineering.

Regarding the owner, it was proved that the enterprises with the foreign owner use traditional and new methods of lean production more, compared to the Czech enterprises. Significant differences were found for Kanban and continuous improvement, as the traditional methods, and for VSM and 5S, as the new methods. However, there are no major differences between the use of new and traditional methods.

Regarding the aims of our research, it was showed that there is still a big potential for implementation of new methods of production improvement in small and middle-sized enterprises. Some of the methods even might be easy and financially available and help enterprises to improve quality of their production.

Literature

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