“Lean management methods: Evidence from the manufacturing industry in the Czech Republic”

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LEAN MANAGEMENT METHODS: EVIDENCE FROM THE MANUFACTURING INDUSTRY IN THE CZECH REPUBLIC

Abstract

Lean management is a way to satisfy the increasing customer demands while maintaining production efficiency. This paper aims to map and analyze the level of use of lean management methods in the manufacturing industry in the Czech Republic. It searched for links and dependencies between company size, production type, and lean management methods in operational processes. The data were obtained from a nationwide survey within the manufacturing industry companies and were presented using descriptive statistics. A structured questionnaire was sent to 469 manufacturing companies with a return rate of 18.8%. Nonparametric statistical analysis (Fisher's exact test) was used to confirm or reject the hypotheses. The research results confirmed the dependence of lean management methods on company size and production type. Lean management methods are used mainly by large enterprises, while micro- and small enterprises rarely employ them. Considering production typology, lean management is applied in serial production, and Single Minute Exchange of Dies (SMED) prevails. The most used techniques in mass production include the method of order in the workplace (5S) and Kaizen. The findings suggest that the future of industrial output should focus on sustainability and rationalization of production resources, which is offered by the synergy of lean management and Industry 5.0.

Keywords lean management, improvement, standardization, sustainability, waste

JEL Classification M21, L23, L26

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INTRODUCTION

The manufacturing sector is the backbone of industrial production in the Czech Republic. This sector is significantly involved in creating fundamental performance indicators, such as gross domestic product, employment, and exports. As a result of COVID-19 and the Russian-Ukrainian war, the reliability and sustainability of industrial chains and processes have been disrupted. It is necessary to constantly look for new approaches to ensure productivity and efficiency in creating output. The requirements for sustainable approaches influence the current market environment. Industry 5.0 also takes these trends into account.

One tool for streamlining and rationalizing processes is the long-term philosophy of lean management, which focuses on maximizing customer value while minimizing waste. Among its indisputable advantages are the elimination of waste, shortening of continuous production time, increase in product quality parameters, and continuous improvement with the support of all employees. A sufficient amount of evidence and case studies are needed to examine the dependence between the use of lean management tools and the size of the company or the type of production.

1. LITERATURE REVIEW

The competitive business environment continues to intensify due to the influence of ever-advancing globalization, the sustainability trend, and the growth of new technologies due to the fourth and fifth industrial revolutions. The critical factor for the company's successful operation is the improvement of processes, whether production or non-production. A key factor for sustaining business in a competitive environment is constant progress in organizational and operational processes (Vera & Zapata, 2022). Because of the sustainability trend, customers' attitudes are changing as they demand sustainable products and services. Customers are willing to pay more for these products (Bastas, 2021).

Liutkeviciene et al. (2022) found that companies can improve their overall performance and reach competitive advantages by adjusting their business processes. There is a number of respective methodologies and approaches. One of the proven ones is lean management. Production can be understood as a value-creating process ensuring the transformation of production resources into final products. A production process can be understood as a set of production operations and procedures requiring different components and resources. The individual steps follow each other, and one can define their input and output (Ahn & Chang, 2019). Lean is a collection of methods to improve company`s performance (van Assen, 2021). It is based on the principles developed at Toyota, focused on reducing waste and improving business processes (Diogo et al., 2021). Waste is understood as defects, overproduction, delays, transportation, overprocessing, inventory, and movement (Khoza et al., 2022). Lean management results in eliminating waste in processes, better use of resources, increased quality in individual operations, and the processing of continuous production time. These are essential requirements of customers (Barabas & Florescu, 2022).

As part of lean methods, a number of tools and techniques are used in different stages of the production process and in different types of production, which aim to eliminate clients' complaints and work stress and enhance employee well-being (Naeemah & Wong, 2023). For the input analysis, it is necessary to know the course of the primary and partial processes. Value stream mapping is used to analyze the flow of values in production or administrative processes to display the actual performance and prospects of companies (Batwara et al., 2023). The output of this method is two maps. The actual performance map shows the company's current state, while the prospect state map shows how the company will behave after specific changes are implemented (Suhardi et al., 2020). Based on legislative regulations, it is crucial to identify and eliminate operation and workplace risks. One of the ways to create a lean and safe workplace is the implementation of the 5S method.

5S is the foundation of all improvements and is key to establishing a visual workplace. Due to the implementation of the 5S, safety in the working environment is improved (Kumar et al., 2022). The most common and most implemented tool of a lean and safe workplace is the 5S method, which finds use in both industrial and service areas (Manzanares-Canizares et al., 2022). This method is fully compatible with other lean management tools, such as Total Productive Maintenance (TPM), the Kanban pull system, Kaizen-type improvement tools, and others (Randhawa & Ahuja, 2018).

Several lean management methods are often implemented using elements of project management (Amaral et al., 2022; Milosevic et al., 2021). For example, Plan-Do-Check-Act (PDCA) is used to establish stages for the improvement plan and set ways to enhance its success (Wani et al., 2019). Another method of lean production is the Single Minute Exchange of Dies (SMED) method, which is used to reduce machine setup time (Juárez-Vite et al., 2023). The expert Shigeo Shinge used this method for the first time in the Toyota factory to reduce print preparation time in 1969. In recent years, several scientific studies have proven the SMED method is successful (Nikolić et al., 2023). For the method to be successfully applied, it must be accompanied by another method or technique – e.g., 5S or Poka-Yoke (Juárez-Vite et al., 2023).

Jurík et al. (2020) distinguish four basic steps, which are the separation of internal and external activities during the transition to a new system, shortening the time of internal activities, shortening the time of external activities, shortening the time of the

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process of transition to a new system. Andon approach monitors the machinery's state and obtains information about its operation (Cortes-Aguilar et al., 2022; Ko & Kuo, 2020). Individual alarm signals are determined by the international standard IEC 60073:2002, where (Cortes-Aguilar et al., 2022) red means failure or emergency stop, yellow sends a warning signal about abnormal process status or machine stoppage, green indicates regular operation, and blue and white are signals set by the user.

The Poka-Yoke method comes from the Toyota company, which was developed by Shigeo Shingo. The method's goal is to prevent human errors by designing process limitations or eliminating quality control (Martinelli et al., 2022) using anything that can detect errors that can reduce the quality of the end product (Santos et al., 2023). Common devices that are used in Poka-Yoke systems are flashing lights, alarms, sensors, and sliding rails (Wijaya et al., 2020).

After the introduction of lean methods, it is necessary to maintain continuous and gradual improvement in the long term, using, for example, Kaizen (Berhe, 2022). This Japanese approach states that even the slightest changes result in significant improvements in waste reduction (Flug et al., 2022). These changes include suggestions and creative ideas of employees who strive to constantly enhance the quality of production and processes (Minh & Quyen, 2022).

In recent years, however, companies have been under increasing pressure for sustainability from legislative regulations and customers. Lean management is a practical tool to reduce production waste and achieve operational success (Teixeira et al., 2021). Industries also need help with ensuring the sustainability of their production logistics processes. These processes integrate economic, environmental, and social aspects. The effective implementation of lean methods can help achieve these aspects. Companies can achieve a significant competitive advantage by connecting lean management and sustainable principles, as these concepts share similar targets. Therefore, company management and scientists are particularly interested in researching the relationship between lean management and company sustainability (Bertagnolli et al., 2021). Both concepts concentrate on reducing waste and increasing the value of companies (Suresh et al., 2023). Previous studies provided evidence of the effective connection of green-lean methods for sustainability (Siegel et al., 2024; Kosasih et al., 2023; Ciannella & Santos, 2022; Teixeira et al., 2021). Based on these statements, it is evident that the effective integration and synergy of lean management methods and sustainable development principles can become a factor of competitiveness in manufacturing companies.

The paper aims to map lean management methods in the manufacturing industry of the Czech Republic. The purpose was to search for links and dependencies between company size, production type, and lean management methods in operational processes.

Scientific questions (Q1 and Q2) were formulated and elaborated into hypotheses (null – H0 and alternative – H1):

Q1: How is the use of lean management methods related to the company size in the manufacturing industry in the Czech Republic?

H1.0: Lean management methods in the manufacturing industry do not depend on the company size.

H1.1: Lean management methods in the manufacturing industry depend on the company size.

Q2: How is the use of lean management methods related to the typology of production processes?

H2.0: Lean management methods in the manufacturing industry do not depend on the type of production.

H2.1: Lean management methods in the manufacturing industry depend on the production type.

2. METHODOLOGY

The quantitative research method was chosen to obtain relevant data. Based on the study of these sources, a structured questionnaire focused on the

use of lean methods and their contribution to the company was compiled. The categorization criterion was the manufacturing industry. Another comparative criterion was the type of production process – mass, series, or piece production. Enterprises were classified according to the number of employees by the breakdown according to the European Commission. Questionnaires were sent to 469 enterprises, of which 88 were returned. The return rate of questionnaires was 18.8%. The most significant number of enterprises, 69.3%, belonged to the category of large enterprises (over 250 employees), 18.2% were medium enterprises (50-249 employees), 6.8% were micro (1-9 employees), and 5.7% were small businesses (10-49 employees). Regarding production and non-production processes, the most significant part of enterprises belonged to serial production (53.4%), then to mass production (21.6%), piece production (18.2%), and the least to commercial intermediary – services (6.8%).

A total of 88 companies participated in the survey, but only 67 of them stated that they use lean management methods (76.1% of monitored enterprises). The obtained data were evaluated using basic descriptive statistics. Nonparametric statistical analysis (Fisher's exact test) was used to confirm or reject the hypotheses.

3. RESULTS

The first research question focused on the dependence between company size and lean management. Table 1 shows the number of companies by size and use of lean management. It can be seen that a micro-enterprises addressed do not use lean management. On the contrary, 90.2% of large enterprises with more than 250 employees apply lean management. At the same time, these enterprises make up the most significant part of the monitored enterprises. The use of lean management methods is statistically significantly dependent on company size (Modified Fisher exact test, p-value < 0.001). Based on these statistical findings, H1 can be confirmed.

Table 2 lists lean management methods depending on company size. Small businesses only use the PDCA cycle from the offered methods. Medium-sized enterprises most often use the 5S method of standardization and workplace order. This method is used by 90.9% of medium-sized enterprises (10 enterprises), followed by Kaizen (36.4% of medium-sized enterprises; 4 enterprises). In the case of large enterprises, the most used method is the 5S method of standardization and workplace order. This method is used by 87.3% of monitored enterprises (48 large enterprises). The second most frequently cited method is again Kaizen. This method was reported by 70.9% of large enterprises (39 enterprises).

There are differences in the popularity and frequency of use within the methods. However, if companies already use the methods, the frequencies between individual companies are no longer statistically significantly different for any of the monitored methods (all p-values of the Modified Fisher exact test are higher than the significance level $\alpha = 5\%$) (Table 3).

The second research question focused on the typology of production processes. Thus, the relationship between the use of lean management methods and the type of production in the Czech Republic's manufacturing industry was investigated.

Table 4 shows the use of the lean management method according to the type of production processes. It can be seen that lean management is

Table 1. Use of lean management methods by company size

Characteristics		Do you use lean management methods?		Total
		Yes	No	
Company size by employees	Microenterprise (1-9 employees)	0 (0%)	6 (100%)	6 (100%)
	Small enterprise (10-49 employees)	1 (20%)	4 (80%)	5 (100%)
	Medium enterprise (50-249 employees)	11 (68.8%)	5 (31.3%)	16 (100%)
	Large enterprise (250 and more employees)	55 (90.2%)	6 (9.8%)	61 (100%)
Total		67 (76.1%)	21 (23.9%)	88 (100%)

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Table 2. Lean management methods for standardization and process management according to company size

For standardization and control of processes from Lean methods, you use:		Company size by employees			
		Small enterprise (10-49 employees)	Medium enterprise (50-249 employees)	Large enterprise (250 and more employees)	Total
Value Stream Mapping	Yes	0 (0%)	2 (18.2%)	20 (36.4%)	22 (32.8%)
	No	1 (100%)	9 (81.8%)	35 (63.6%)	45 (67.2%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
The method of standardization and workplace order 5S	Yes	0 (0%)	10 (90.9%)	48 (87.3%)	58 (86.6%)
	No	1 (100%)	1 (9.1%)	7 (12.7%)	9 (13.4%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Shop Floor Management	Yes	0 (0%)	6 (54.5%)	32 (58.2%)	38 (56.7%)
	No	1 (100%)	5 (45.5%)	23 (41.8%)	29 (43.3%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
PDCA cycle	Yes	1 (100%)	5 (45.5%)	23 (41.8%)	29 (43.3%)
	No	0 (0%)	6 (54.5%)	32 (58.2%)	38 (56.7%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Kaizen	Yes	0 (0%)	7 (63.6%)	39 (70.9%)	46 (68.7%)
	No	1 (100%)	4 (36.4%)	16 (29.1%)	21 (31.3%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Andon	Yes	0 (0%)	1 (9.1%)	12 (21.8%)	13 (19.4%)
	No	1 (100%)	10 (90.9%)	43 (78.2%)	54 (80.6%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
SMED – A method of reducing production equipment retyping times	Yes	0 (0%)	6 (54.5%)	28 (50.9%)	34 (50.7%)
	No	1 (100%)	5 (45.5%)	27 (49.1%)	33 (49.3%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)

Table 3. Modified Fisher's exact test: Dependence of company size and the use of lean management methods for standardization and process control

Modified Fisher's exact test	p-value
Value Stream Mapping	0.538
The method of standardization and workplace order 5S	0.165
Shop Floor Management	0.725
PDCA cycle	0.725
Kaizen	0.331
Andon	0.741
SMED – A method of reducing production equipment retyping times	1.000

most often used by enterprises with serial (89.4% of these enterprises) and mass production (89.5%). On the contrary, it is used only by 37.5% of enterprises engaged in piece production and 33.2% of enterprises engaged in intermediary services. It is, therefore, not surprising that the use of the lean management method statistically significantly depends on the type of production processes (Modified Fisher's exact test; p-value < 0.001) (Table 5).

Therefore, the survey includes enterprises that most often deal with serial production (53.4%; 47 enterprises) or mass production (21.6%; 19 enterprises).

Table 5 shows the results of the modified Fisher's exact test. Statistically significant differences in the use of lean management methods are only in the case of the Kaizen method (p-value = 0.035) and the SMED approach (p-value = 0.003). Based on the statistical results, H2 was confirmed.

For greater clarity, Table 6 lists individual methods of lean management and types of production processes. Mass production enterprises most often use the 5S method of standardization and workplace order and Kaizen. These methods are used by 88.1% and 73.8% of enterprises with serial production. Enterprises with mass production most

Table 4. Use of lean management methods according to production processes

Characteristics		Do you use lean management methods?		Total
		Yes	No	
Your type of manufacturing/ non-manufacturing processes	Serial production	42 (89.4%)	5 (10.6%)	47 (100%)
	Mass production	17 (89.5%)	2 (10.5%)	19 (100%)
	Piece production	6 (37.5%)	10 (62.5%)	16 (100%)
	Business Intermediary – Services	2 (33.3%)	4 (66.7%)	6 (100%)
Total		67 (76.1%)	21 (23.9%)	88 (100%)

Table 5. Modified Fisher's exact test: Dependence of production processes and the use of lean management methods for standardization and management of processes and type of production

Modified Fisher's exact test	p-value
Value Stream Mapping	0.803
The method of standardization and workplace order 5S	0.731
Shop Floor Management	0.452
PDCA cycle	0.452
Kaizen	0.035
Andon	0.928
SMED – A method of reducing production equipment retyping times	0.003

often use these methods. More often than other companies, serial production businesses also use SMED, which shortens the time spent retyping production equipment. For example, batch production businesses rarely use Kaizen compared to other businesses. This method is used by only 16.7% of batch production enterprises, which generally use lean management methods.

Trade and brokerage service businesses, which consist of only two companies, use the 5S method of standardization and workplace order, Shop

Table 6. Lean management methods for standardization and process control according to the type of production processes

For standardization and control of processes from Lean methods, you use:		Your type of manufacturing/non-manufacturing processes				
		Serial production	Mass production	Piece production	Business Intermediary – Services	Total
Value Stream Mapping	Yes	15 (35.7%)	6 (35.3%)	1 (16.7%)	0 (0%)	22 (32.8%)
	No	27 (64.3%)	11 (64.7%)	5 (83.3%)	2 (100%)	45 (67.2%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
The method of standardization and workplace order 5S	Yes	37 (88.1%)	14 (82.4%)	5 (83.3%)	2 (100%)	58 (86.6%)
	No	5 (11.9%)	3 (17.6%)	1 (16.7%)	0 (0%)	9 (13.4%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
Shop Floor Management	Yes	25 (59.5%)	9 (52.9%)	2 (33.3%)	2 (100%)	38 (56.7%)
	No	17 (40.5%)	8 (47.1%)	4 (66.7%)	0 (0%)	29 (43.3%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
PDCA cycle	Yes	17 (40.5%)	8 (47.1%)	2 (33.3%)	2 (100%)	29 (43.3%)
	No	25 (59.5%)	9 (52.9%)	4 (66.7%)	0 (0%)	38 (56.7%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
Kaizen	Yes	31 (73.8%)	12 (70.6%)	1 (16.7%)	2 (100%)	46 (68.7%)
	No	11 (26.2%)	5 (29.4%)	5 (83.3%)	0 (0%)	21 (31.3%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
Andon	Yes	8 (19%)	4 (23.5%)	1 (16.7%)	0 (0%)	13 (19.4%)
	No	34 (81%)	13 (76.5%)	5 (83,3%)	2 (100%)	54 (80.6%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)
SMED – A method of reducing production equipment retyping times	Yes	28 (66.7%)	5 (29.4%)	1 (16.7%)	0 (0%)	34 (50.7%)
	No	14 (33.3%)	12 (70.6%)	5 (83.3%)	2 (100%)	33 (49.3%)
	Total	42 (100%)	17 (100%)	6 (100%)	2 (100%)	67 (100%)

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Table 7. Impacts of lean management by company size

The introduction of lean management principles had an impact on:		Company size by employees			
		Small enterprise (10-49 employees)	Medium enterprise (50-249 employees)	Large enterprise (250 and more employees)	Total
Reduction of production lead time	Yes	0 (0%)	4 (36.4%)	35 (63.6%)	39 (58.2%)
	No	1 (100%)	7 (63.6%)	20 (36.4%)	28 (41.8%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Increasing the fluidity of material flows	Yes	0 (0%)	8 (72.7%)	35 (63.6%)	43 (64.2%)
	No	1 (100%)	3 (27.3%)	20 (36.4%)	24 (35.8%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Increasing the availability of production equipment (the time during which the equipment is available)	Yes	0 (0%)	4 (36.4%)	27 (49.1%)	31 (46.3%)
	No	1 (100%)	7 (63.6%)	28 (50.9%)	36 (53.7%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Increasing the productivity of machines and equipment	Yes	1 (100%)	9 (81.8%)	39 (70.9%)	49 (73.1%)
	No	0 (0%)	2 (18.2%)	16 (29.1%)	18 (26.9%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Increasing worker productivity	Yes	1 (100%)	10 (90.9%)	38 (69.1%)	49 (73.1%)
	No	0 (0%)	1 (9.1%)	17 (30.9%)	18 (26.9%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Increasing the production capacity of machines	Yes	0 (0%)	4 (36.4%)	33 (60%)	37 (55.2%)
	No	1 (100%)	7 (63.6%)	22 (40%)	30 (44.8%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Turnover increase	Yes	0 (0%)	3 (27.3%)	12 (21.8%)	15 (22.4%)
	No	1 (100%)	8 (72.7%)	43 (78.2%)	52 (77.6%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Cost reduction	Yes	1 (100%)	7 (63.6%)	35 (63.6%)	43 (64.2%)
	No	0 (0%)	4 (36.4%)	20 (36.4%)	24 (35.8%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Reduction of machine breakdowns	Yes	0 (0%)	4 (36.4%)	22 (40%)	26 (38.8%)
	No	1 (100%)	7 (63.6%)	33 (60%)	41 (61.2%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Reduction in scrap percentage	Yes	0 (0%)	7 (63.6%)	20 (36.4%)	27 (40.3%)
	No	1 (100%)	4 (36.4%)	35 (63.6%)	40 (59.7%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Reduction of accidents or occupational diseases	Yes	0 (0%)	0 (0%)	6 (10.9%)	6 (9%)
	No	1 (100%)	11 (100%)	49 (89.1%)	61 (91%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)
Turnover reduction	Yes	0 (0%)	0 (0%)	4 (7.3%)	4 (6%)
	No	1 (100%)	11 (100%)	51 (92.7%)	63 (94%)
	Total	1 (100%)	11 (100%)	55 (100%)	67 (100%)

Floor Management, PDCA cycle, and Kaizen in 100% of cases. They do not use any other methods.

The impacts of lean management on company size are shown in Table 7. It can be seen that small businesses value the increase in machine productivity, worker productivity, and cost reduction the most. Medium-sized enterprises also appreciate the increase in employee productivity and machines and equipment. Large businesses appreciate the same benefits as medium-sized businesses. Medium-sized enterprises appreciate the reduction of the continuous production time of the product.

4. DISCUSSION

The research results statistically confirmed that lean management methods are mainly used by large industrial enterprises, supporting Bhasin (2012) and Van Landeghem (2014). It was also found that larger organizations have a more robust monitoring and control system. Large enterprises have more resources and capital and more modern technologies and can thus achieve synergies by connecting lean management methods with information technologies. Another aspect is that most lean management methods should be

implemented by project teams, which is typical for organizations with a larger number of employees. Larger firms also have a better bargaining position when securing inputs. It can thus put pressure on its suppliers and streamline processes within the supply chain.

The most used method in both large and medium-sized enterprises is the 5S method. Shahriar et al. (2022) stated that the 5S method helps decrease idle time and non-value-added operations. The second most frequently used method is Kaizen. In connection with the ongoing Industry 4.0, it seems appropriate to connect the philosophy of Kaizen with elements of digitization. Dang-Pham et al. (2022) addressed the integration of the Kaizen approach into the digital transformation of a business. However, digitization does not mean Kaizen. It is only a tool to support proper Kaizen implementation and simplified data collection.

The findings show that 36.4% of large enterprises use value stream mapping to analyze their production processes. Habib et al. (2023) proved the shortening of the delivery time and the increase in competitiveness when using value stream mapping. However, companies require management control over value stream mapping to make sure that employees cooperate with each other and support the creation of value to achieve real benefits (Habib et al., 2023). Today, integration with 4.0 technologies already uses value stream mapping 4.0, which analyzes data in real time. Kihel et al. (2022) demonstrated the functionality of this technology in automotive conditions. Digital models are currently used to plan production logistics processes. Therefore, it is necessary to integrate lean methods into one information platform together with these models. Godoy et al. (2023) and Sundararajan and Terkar (2022) provide evidence of a positive effect on increasing productivity and reducing downtime in production.

CONCLUSION

The study focused on the manufacturing industry in the Czech Republic. The main goal was to evaluate the use of lean management methods in relation to company size and the type of production process due to the lack of relevant studies.

The results confirm the hypothesis that there is a dependency between lean management and the size of the company. Large companies have financial, technological, and human advantages to apply lean methods across different departments, thus achieving a unified approach and connection of value-creating flows. Next, the study found the dependence of lean management on the production type. Lean management is mainly used in mass production. Although serial production does not achieve complete efficiency like mass production, by applying the principles of lean methods, it is possible to significantly reduce waste, increase throughput, shorten lead times, and overall optimize material flow in this type of production. An important role is played by the SMED method, which makes it possible to shorten the time when retyping machines and lines between individual series. Significant synergistic effects are achieved by linking the lean management method with Industry 4.0 elements.

Currently, the industry is preparing for the transition to Industry 5.0, which brings new challenges for industrial enterprises. The main pillars are safety, sustainability, and human resources. Industry 5.0 represents the next stage of the intelligent industry. New Industry 5.0 technologies can be effectively used for digitization and automation of lean tools and principles, such as visual management, traction systems, maintenance management systems, Andon, Poka-Yoke, etc. It also allows obtaining accurate data in real time for effective implementation of Kaizen principles.

The limitation of the research was the focus on the Czech Republic and selected industry sector. Further research should focus on the connection between lean management and Industry 5.0.

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AUTHOR CONTRIBUTIONS

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