SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 191

IMPLEMENTATION STATUS OF LEAN MANAGEMENT IN POLISH MANUFACTURING ENTERPRISES

Anna STRONCZEK

AGH University of Krakow; stroncz@agh.edu.pl, ORCID: 0000-0001-9343-936X

Purpose: The aim of this study was to assess the extent of Lean Management implementation in Polish manufacturing enterprises that declare the adoption of the lean philosophy. The study also aimed to identify areas for further development and provide practical recommendations for companies seeking to enhance their Lean Management practices.
Design/methodology/approach: A quantitative approach was employed, utilizing a survey of Polish manufacturing enterprises to assess the degree of implementation of Lean Management principles in key areas such as customer relationships, supplier relationships, employee engagement, Total Productive Maintenance (TPM), and pull/flow processes. The comprehensive survey covered a wide range of Lean Management practices and was administered online to a sample of Polish manufacturing enterprises. Data from the survey was analyzed using a variety of statistical techniques, including descriptive statistics, correlation analysis, and regression analysis. The data was used to identify patterns and trends in Lean implementation practices.
Findings: The results of the study indicated that Lean Management practices are relatively well-established in Polish manufacturing enterprises in each of the assessed areas. However, significant differences were observed between areas, with the highest levels of implementation observed in customer relationships and employee engagement, and the lowest in supplier relationships and pull/flow processes.
Research limitations/implications: The primary limitations of the study lie in its reliance on self-assessment data and the potential bias of respondents. Additionally, the generalization of results is limited to a specific sample of Polish manufacturing enterprises. Nevertheless, the study provides valuable insights into the current state of Lean Management implementation in Poland and identifies areas for further development.
Practical implications: The study suggests that Polish manufacturing enterprises should prioritize the continued implementation of lean practices in the areas of supplier relationships and pull/flow processes. This requires coordinated efforts to strengthen supplier relationships, optimize supply chain management, and implement lean production principles to eliminate waste and enhance efficiency.
Originality/value: The study contributes to existing knowledge on Lean Management implementation by providing a comprehensive assessment of its current state in Polish manufacturing enterprises. The findings offer practical guidance for companies seeking ways to improve their Lean Management practices and derive associated benefits.
Keywords: Lean Management, strategy, lean implementation.
Category of the paper: research paper.

1. Introduction

The term "lean production" first appeared in scientific literature through the work of Womack and Jones in 1990 (Womack, Jones, 1990). Nevertheless, the roots of this innovative strategy trace back further, with its genesis attributed to the Toyota Production System (TPS). Over time, the concept of "lean" has evolved, encompassing a broader context of enterprise management known as Lean Management (LM) (Psomas, Antony, 2019; Gil-Vilda et al., 2021). At the core of this concept lies the idea of creating a high-quality production system that effectively responds to changing customer needs while simultaneously minimizing waste, treated as inefficiency (Shah, Ward, 2003).

The popularity of Lean Management as an innovative management strategy has persisted continuously since the 1980s. This concept has not only gained recognition but has also become a key element of modern approaches to effective business management. According to the principles of LM, companies should shape their strategies based on delivering value to customers, striving to eliminate waste both internally and throughout the supply chain (Sinha, Matharu, 2019). Embracing this concept is a foundational decision for a company, determining operational effectiveness, process optimization, and delivering products with the highest value to the customer. Previous research on Lean Management in Poland has primarily focused on analyzing tools and methods used in this concept (e.g., Walentynowicz, 2013; Kleszcz et al., 2019; Ulewicz et al., 2022), and the impact of adopting the concept on organizational outcomes (e.g., Saudi et al., 2019; Piasecka-Głuszak, 2023). However, studies concentrating on the scale of implementation in the context of manufacturing enterprises that have declared the adoption of a lean strategy are very limited and scarce (e.g., Niewiadomski, Oleśków-Szłapka, 2017; Nowotarski, Paslawski, 2018; Łyszkowska, 2022).

To address this knowledge gap, the research question posed in this study is: To what extent have Polish manufacturing enterprises, declaring the adoption of lean philosophy, implemented lean management practices across key areas, and what are the observed variations in the implementation levels among these areas?

Therefore, the main aim of this study was to understand the degree of LM implementation in Polish manufacturing companies declaring the adoption of the lean philosophy. Additionally, our research seeks to develop specific recommendations for manufacturing companies in Poland regarding the further development of LM.

We would like to emphasize that our study provides original insights into the extent of Lean Management implementation in Poland, making a significant contribution to the advancement of knowledge on this subject.

2. Lean Management in manufacturing enterprises

The concept of Lean Management has been developing for many years and continues to evolve. Despite the vast amount of literature associated with it, definitively establishing its nature is a complex task. Different interpretations emphasize various aspects of this concept, with some arguing that creating a rigid definitional framework is impossible due to its constant development (Hines et al., 2004).

Authors present the lean approach to production processes in the form of five principles, applicable to both the entire enterprise and individual processes or actions of specific employees. These principles (Womack, Jones, 2003, p. 10; Trzcieliński 2011, pp. 27-29) include:

- Precisely defining the value that a given product presents to the customer (specify the value).
- Identifying the value stream for each product (identify the value stream).
- Ensuring uninterrupted flow for this stream (flow).
- Organizing the manufacturing process in a way that the customer "pulls" the product to the market from the producer (pull).
- Creating a culture of continuous improvement and striving for perfection (perfection).

Customer-oriented value is crucial in the lean approach, serving as the foundation around which the entire value chain of Lean Management is built. Customer orders trigger production in a streamlined environment (Hutchinson, Liao, 2009). All activities that do not meet customer expectations and needs are classified as waste (Shook, 2007; Liker, Ross, 2017). Customers, as stakeholders, define value, specifying what they appreciate in each product/service, the price they are willing to pay, and the acceptable delivery time (Womack, Jones, 2003; Kennedy, Brewer, 2005; Putnik, 2012).

Lean Management requires proper consideration of resources: how to handle them, their location, utilization, and management. The efficiency of resource utilization is determined by how they are used (Czarnecki, 2010, pp. 59-61). In this context, Lean Management focuses on four coherent goals: (Nogalski, Walentynowicz, 2007):

- short production cycle with simultaneous high integration of the production proces,
- timely deliveries achieved through collaborative cooperation with suppliers,
- minimal inventory,
- maximum utilization of production capacity.

Avoiding dispersion and waste appears in all attempts to define the lean concept. Actions in this regard aim to reduce "muda" (a Japanese term for waste, futility, unnecessary consumption). Activities that do not add value include buffer stocks, safety stocks, waiting times, warranty repairs. The lean concept promotes the principle that every process can be further rationalized, eliminating often unnoticed waste (Gendo, Konschak, 1999, pp. 53-94).

Activities and processes that do not add value result in waste, which can manifest as (e.g., Womack, Jones, 2003, p. 15; Hicks, 2007; Wiśniewska, 2005, p. 4):

- Waste of overproduction – producing too many goods within ongoing processes, exceeding order levels.
- Waste of inventory – finished goods, materials not needed for production, interoperative, leading to increased transportation and storage costs.
- Waste of defects – concerning products, documentation, deliveries, information.
- Waste of waiting – long periods of inactivity for individual resources, e.g., people, machines, parts, materials, resulting from delays in deliveries.
- Waste of overprocessing – involving unnecessary tasks in the implemented process.
- Waste of transportation – unnecessary movement of objects within ongoing processes, resulting from improper designation of transport paths.
- Waste of motion – excessive, unjustified transport of resources, as well as unnecessary tasks performed by workers, e.g., due to poor workplace organization.

Waste of untapped human potential – manifested, for example, by a lack of employee engagement. The eighth type of waste, related to the underutilization of employee creativity, was proposed by J.K. Liker (2005) and has become permanently integrated into the Lean Management concept.

The concept of Lean Management permeates organizations through various systems, such as the Toyota Production System (TPS), Achieving Competitive Excellence (ACE), Continuous Improvement Project (CIP), World Class Manufacturing (WCM), or Six-Sigma. These systems constitute meta-concepts, combining many congruent ideas in the areas of organization and management (Pawłowski et al., 2010). These systems serve as tools enabling organizations to effectively implement Lean Management principles, leading to operational excellence and competitiveness.

While Lean Management is traditionally conceptualized as a set of practices (e.g., Shah, Ward, 2007), it is assumed that these distinct practices should operate collectively as a system (Womack et al., 1990). Stakeholders such as suppliers of raw materials and components, entities providing services in sales, customer service, or post-sales service have a significant impact on production costs, the quality of the final product, and the flexibility of organizational operations. Extending Lean Management beyond the boundaries of an organization, through interorganizational cooperation, necessitates convincing these entities to introduce improvements in their processes to jointly create the maximum value for the end customer. Therefore, it is crucial to treat stakeholders collaboratively and ensure a fair distribution of benefits obtained from jointly conducted activities. Hence, questions in the survey were included in the area of interorganizational relations.

An important feature of the supply chain where Lean Management principles have been introduced is the pursuit of reducing the number of suppliers. Simultaneously, emphasis is placed on establishing long-term relationships within cooperation, with a carefully selected group of partners, to ultimately improve common processes, enhance quality, and engage business partners in designing and refining products. If a company simultaneously aims to reduce inventory by implementing the just-in-time method, there is often a preference for suppliers in close proximity. However, some companies implementing Lean Management are concerned that limiting the number of suppliers, combined with reducing inventory size, may increase the risk of disruptions in operations in situations involving non-standard events resulting in delays or interruptions in deliveries. Such situations may include random events (fire, flood), strikes, or pandemics.

3. Research method

The aim of the conducted research was to assess the extent of the application of Lean Management in Polish manufacturing companies declaring the adoption of the lean philosophy. Empirical studies were conducted based on data obtained from anonymous surveys conducted in companies implementing Lean Management. The participating firms declared the use of methods and tools characteristic of LM.

The construction of the research tool stemmed from the research objectives. The questionnaire consisted of several groups of questions, although not all areas were utilized in this study. The first group of questions focused on company information and aimed to identify the general characteristics of the surveyed entities. Questions covered the ownership structure of the company, whether the company is part of a capital group, location of operations, size of the unit (measured by the number of employees), declared strategic goals of the studied company, and the sector and industry of activity. The second part of the survey was directed at information about the respondents, with questions pertaining to the department of employment, the role held, and the duration of work in the surveyed company.

The third part identified the level of implementation of LM in the surveyed company. As previously mentioned, since there is no exhaustive catalog of tools and methods of LM, the level of maturity in lean is diagnosed through a series of characteristics and attributes of leanness. Utilizing a method of reconstruction and interpretation of literature, a general catalog of descriptors related to the concept of LM was identified. The operationalization for the LM construct was based on existing literature and previous studies (Stronczek, 2022). The discussed construct is multidimensional and has a latent nature. Lean is modeled as a second-order construct representing complementarities among first-order factors, which include relationships with suppliers and customers, pull and flow processes, employee empowerment, and TPM.

The dimensions (desiderata) adopted for assessing the level of implementation of the LM concept were described in Table 1. The developed instrument covered both internal and external practices. In this research area, modified measurement scales of lean production developed by R. Shah and P. T. Ward (2007) were used. In the third part of the survey, there was also a control question regarding respondents' self-assessment of the level of Lean Management implementation in the surveyed company. A 5-point Likert scale (where 1 - strongly disagree, 2 - somewhat disagree, 3 - neutral, 4 - somewhat agree, 5 - strongly agree) was used to assess operationalized variables.

Table 1.
The construction of a measurement tool in the field of the advancement of Lean Management practices

Area	Construct Descriptor	Construct Details
Customer Relationships	Customer Relationships are evaluated by assessing customer needs and expectations. Customers are actively engaged in quality improvement projects. Consumer satisfaction is measured. Close contact is maintained with key customers.	– We are often in close contact with our customers. – Our customers provide us with their opinions regarding the quality and timeliness of deliveries. – Our customers are actively involved in shaping the current and future product offerings. – Our customers frequently share with the marketing departments current and future demand-related information. – We regularly conduct customer satisfaction surveys.
Supplier Relationships	We use a small number of suppliers. Suppliers are engaged in product development and quality improvement projects. Suppliers are evaluated based on quality	– We are often in close contact with our suppliers. – We aim to establish long-term relationships with our suppliers. – Our key suppliers provide us with just-in-time deliveries. – We engage in corporate-level communication with key suppliers on important matters. – We take specific steps to reduce the number of suppliers for each specialty. – We provide feedback to our suppliers regarding the quality and timeliness of their deliveries. – Suppliers are directly involved in the process of developing new products.
Employee Engagement	A participatory organizational culture is preferred, where employees are trained and responsible for suggesting improvements, making decisions, and ensuring the quality of outcomes.	– The majority of production floor workers are cross-trained. – Operational employees are actively involved in improvement activities and have the authority to make changes. – The work environment is organized so that most tasks are performed in teams. – Employees regularly submit individual and team ideas for improvement. – Leadership is engaged in quality-related training. – All employees are encouraged to suggest solutions to problems. – A structured employee training program is implemented and adhered to.

Cont. table 1.

Processes: "Pull" and "Flow"	The manufacturing process is organized in a way that ensures the product is "pulled" to the market by the customer (both external and internal) (pull).	– Production is "pulled" by the shipment of finished products. – Production at each workstation is "driven" by demand from the next workstation. – We use containers, cards, or Kanban boards to control production.
	We strive to ensure uninterrupted flow (flow).	– Products are grouped based on similar processing requirements. – Equipment is grouped to ensure continuous flow of product families.
Total Productive Maintenance (TPM)	We implement comprehensive maintenance by systematically servicing equipment and maintaining documentation of related activities.	– We allocate time for planned equipment maintenance in our daily activities. – We regularly maintain all of our production equipment. – We meticulously document all activities related to equipment maintenance.

Source: Own work.

In the study, the format of closed-ended questions was considered most appropriate due to time pressure on the respondents and a cultural reluctance to open-ended questions requiring detailed answers.

The questionnaire was initially pre-tested and evaluated by two practitioners familiar with the concept of LM, three experts who are researchers in the field of management, and an academic statistician specializing in research across various management areas. The feedback and suggestions from the specialists, along with the pilot survey (12 surveys), allowed for the verification and improvement of the research tool.

The actual research was conducted from May to August 2021. The survey covered companies that declared the use of methods and tools characteristic of LM. To enhance the accuracy and reliability of responses, the research purpose was presented to respondents, and basic conceptual terms in the questionnaire were explained. Respondents provided answers based on their own knowledge, making the study declarative in nature[1].

4. Results and discussion

As a result of the conducted questionnaire surveys (electronically), a total of 128 complete surveys were obtained after verification, representing manufacturing enterprises. These companies encompassed small firms - 4 (3,12%), medium-sized enterprises - 42 (32,81%), and large enterprises 82 (64,06%). For research purposes, large firms were further divided into two subgroups based on employment size, namely those employing up to 500 people and those with a workforce exceeding this size. Despite variations in size and

[1] Conducting scientific research involving reference to respondents' perceptions is common in management studies (cf. Cyfert, 2012). This is directly driven by researchers' aspirations to advance knowledge in the field of management while simultaneously aiming for the practical applicability of the acquired knowledge.

employment levels among the surveyed entities, these differences did not impact the quality of the conducted research.

An analysis of the characteristics of the capital structure of the represented enterprises indicates that they are based on both Polish and foreign capital, with the majority representing mixed capital. Most of the participating companies were members of capital groups (75,8%). However, a significant portion of them maintained a separate managerial accounting or controlling system (68%). A detailed profile of the surveyed enterprises is presented in Table 2.

The majority of surveyed companies are located in the Silesian and Lesser Poland voivodeships (both at 15,53%), followed by the Masovian voivodeship (12,5%), Pomeranian voivodeship (9,34%), and Greater Poland voivodeship (9,34%).

Characterizing the enterprises participating in the study, it is also valuable to examine the profile of the respondents directly involved in the research. Respondents were individuals representing various areas of enterprise functioning, with the predominant group being employees from production departments (30,47%) and quality departments (28,13%). This situation appears evident in the context of the theory presented earlier (Chapter 1) – often, representatives of these departments become leaders of lean initiatives within companies. It is noteworthy that 10 individuals (7,81%) did not strongly identify with a specific functional area of the enterprise but rather with being a change leader in the lean area (characterizing a cross-functional role).).

Respondents were asked to indicate the area associated with the declared strategic goal of the surveyed enterprise. They could choose up to three areas. The majority of respondents pointed to quality (87,5%), cost (41,41%), and innovation (39,84%). In subsequent positions, but also with high indications, were reliability (34,38%), environmental goal (23,44%), and sustainable development (17,97%). Such a hierarchy of responses is an obvious consequence of choosing Lean as the leading management concept in the surveyed enterprises.

The conducted empirical research allowed for determining the state of LM implementation in the surveyed enterprises. Tables 2-6 present the analysis results considering individual Lean Management areas.

Collaboration with suppliers is a key pillar of effective management in the context of Lean principles. Supplier relationships, being an integral part of this approach, have strategic importance for companies aiming to optimize their supply chain. The research results clearly indicate that the surveyed companies are aware of this significance, emphasizing the building of strong relationships with suppliers.

The results indicate that the dimension "Supplier Relationship Management" (DS) in the surveyed companies was moderately implemented in the examined sample of enterprises. The average value for the entire DS dimension was 3,54 (see Figure 1), which means that practices related to supplier relationship management are common but not fully developed. The highest ratings were obtained for DS6, DS2, and DS1 factors, exceeding the average value

for the entire DS dimension (3,54). The analysis of standardized factor loadings indicates that all values within the DS construct are equal to or exceed 0,3, which is considered significant (see Table 2). Practices DS1, DS2, and DS5 have the greatest impact on the importance of the scale, confirming their crucial role in effective supplier relationship management.

Table 2.
Area: Supplier Relationships

Characteristics	$\bar{x}$	σ	Standardized Factor Loadings	The average correlations of the component with the remaining variables
We are often in close contact with our suppliers (DS1)	4,14	0,86	0,838	0,382
We strive to establish long-term relationships with our suppliers (DS2).	4,13	0,95	0,893	0,398
Our key suppliers provide us with just-in-time (JIT) deliveries (DS3).	3,24	1,11	0,393	0,205
We communicate at the corporate level with key suppliers on important matters (DS4).	3,37	1,19	0,488	0,285
We take specific steps to reduce the number of suppliers for each specialty (DS5)	2,80	1,22	0,411	0,317
We provide feedback to our suppliers on the quality and timeliness of their deliveries (DS6).	4,45	0,79	0,435	0,254
Suppliers are directly involved in the process of developing a new product (DS7).	2,63	1,27	0,300	0,230

$\bar{x}$ - the average.
σ - standard deviation.

Source: Own work.

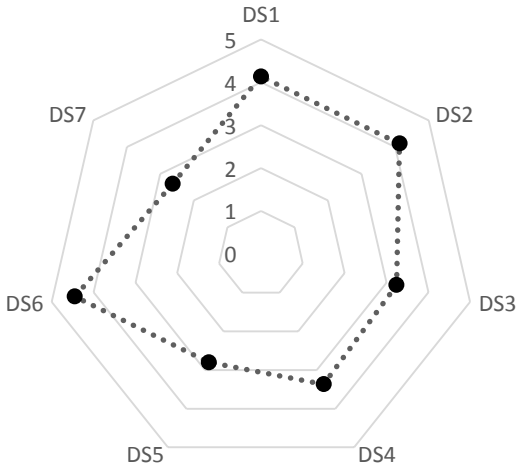

Figure 1. Averages of implementations of practices in the area of "Supplier Relationship Management" in the surveyed companies.

Source: Own work.

The research indicates that companies prioritize building strong relationships with suppliers. However, to reap full benefits from LM, they should focus on further developing these relationships, especially in ensuring timely deliveries and engaging suppliers directly in the process of developing new products.

LM enables companies to achieve various benefits, with key aspects being the optimization of the supply chain, cost reduction, access to new technologies and knowledge, and enhanced competitiveness. The surveyed firms seem to understand this relationship, as confirmed by the obtained results. Nevertheless, to unlock the full potential of LM benefits, there is a need to concentrate on further developing supplier relationships.

The aim of Lean is to create value for the customer by delivering products and services that align with their needs and expectations. Customer relationships are a crucial element of LM (Nogalski, Niewiadomski, 2017). Through these relationships, companies can:

- understand the needs and expectations of customers,
- tailor their offerings to these needs,
- ensure high-quality products and services,
- maintain customer loyalty.

Adapting offerings to customer needs allows companies to create products and services that are genuinely desired by customers and provide them with value. Customer relationships are also important for ensuring the high quality of products and services. Companies that prioritize customer relationships are more inclined to listen to customer opinions and needs. This enables them to quickly identify and address issues with the quality of products and services.

Loyal customers form the foundation of success for any business. Customer relationships help companies maintain customer loyalty by building trust and mutual connections.

In the area of "Customer Relations" (K), the surveyed companies have implemented relevant practices to a significant extent, achieving an average score of 4,25 for the entire dimension K (see Figure 2). The results indicate that practices K1, K2, and K5 have scored above this average. Detailed analyses within this area revealed that all standardized factor loadings for individual practices (compared to the value of 0,3) are at or above this threshold, with the first two practices (K1 and K2) exhibiting the highest loadings.

The achievement of the scale significance is a result of the impact of all practices, confirmed through both the analysis of standardized factor loadings and the average correlations of the component with the remaining variables forming the construct. Although these values are at a low level, they are statistically significant (see Table 3).

Table 3.
Area: Customer Relations

Characteristics	$\bar{x}$	σ	Standardized Factor Loadings	The average correlations of the component with the remaining variables
We are often in close contact with our customers (K1)	4,70	0,60	0,975	0,495
Our customers provide us with feedback on the quality and timeliness of deliveries (K2)	4,65	0,75	0,674	0,379
Our customers are actively involved in shaping the current and future product offerings (K3)	3,44	1,31	0,518	0,331
Our customers frequently share current and future demand information (K4)	3,91	0,99	0,341	0,262
We regularly conduct customer satisfaction surveys (K5)	4,54	0,84	0,500	0,327

Source: Own work.

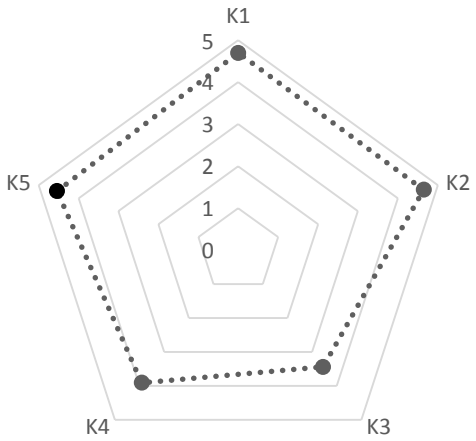

Figure 2. Averages of implementations of practices in the area of "Customer Relationships" in the surveyed companies.

Source: Own work.

High scores in practices K1, K2, and K5 indicate that the surveyed companies prioritize building close relationships with customers. They regularly maintain contact, pay attention to customer opinions and needs, and conduct satisfaction surveys regularly.

Lower scores in practices K3 and K4 may suggest that the surveyed companies have room for improvement in engaging customers in product offerings and obtaining information about their demand.

In the context of LM, close customer contact (practice K1) enables ongoing dialogue, allowing for quicker detection of potential waste areas. Customers providing feedback on quality and timeliness of deliveries (practice K2) enables the adjustment of production processes to meet their expectations, resulting in improved quality and the elimination of unnecessary actions.

Furthermore, active customer engagement in shaping offerings (practice K3) and regular customer satisfaction surveys (practice K5) are key elements of the continuous improvement process. Thanks to these practices, companies can tailor their products and services to real customer needs, thus eliminating unnecessary elements from the production process.

As a result, maintaining close relationships with customers not only influences process improvement but also contributes to building customer loyalty. Companies that actively listen to customer opinions and needs create products that are genuinely desired, leading to customer satisfaction and retention. In this way, customer relationships become an integral part of Lean Management strategy, promoting waste elimination and continuous quality improvement, which are crucial for achieving success in a competitive market environment.

The results indicate that the surveyed companies prioritize building lasting relationships with customers. This is a significant aspect because satisfied customers are more likely to make repeat purchases and recommend the company's products and services to others.

To further improve customer relationships, the surveyed companies may consider the following actions:

- increase customer engagement in shaping product offerings, for example, by organizing contests, surveys, and workshops,
- actively encourage customers to share information about their needs, for instance, by introducing loyalty programs or special offers,
- implement technological solutions that facilitate communication with customers, such as chatbots, live chats, or virtual assistants.

Internal logistics is a crucial component of LM. It is responsible for the flow of items through successive production stages and the delivery of finished products to the warehouse. Its goal is to ensure a smooth and efficient flow of materials, products, and information within the company.

In lean enterprises, internal logistics is based on a pull system. This system involves producing only those components that are needed at a given moment. This approach allows the company to eliminate waste that may occur during the flow of goods.

In the surveyed companies, the "Pull" area was assessed at a level of 3,66, indicating a moderate implementation of the principles in this area (Figure 3). The most effectively implemented practice was Pull2, where production at a workstation is "driven" by demand shown by the next workstation. The average rating for this practice was 4,08, suggesting a high degree of compliance with the principles of the pull system. However, despite the high rating, the standardized factor loading for this practice is only 0,298, which may indicate certain areas for further analysis and improvement (Table 4).

If we look at the practices in the "flow" processes area, it can be observed that although they are rated significantly above the scale's average, the standardized factor loadings are relatively low. This suggests that despite the overall high rating, these practices may be applied in a subjectively positive manner but require some adjustments or enhancements to better meet the criteria of lean system efficiency.

Table 4.
Processes: "pull" and "flow"

Characteristics	$\bar{x}$	σ	Standardized Factor Loadings	The average correlations of the component with the remaining variables
Production is "pulled" by the shipment of finished products (Pull1)	3,83	1,35	0,575	0.205
Production at each workstation is "driven" by demand from the next workstation (Pull2)	4,08	1,10	0,298	0,132
We use containers, cards, or Kanban boards to control production (Pull3)	3,07	1,38	0,797	0,249
Products are categorized into groups with similar processing requirements (Flow1)	4,57	0,61	0.167	0,123
Equipment is grouped to ensure a continuous flow of product families (Flow2)	4,37	0,79	0.235	0,159

Source: Own work.

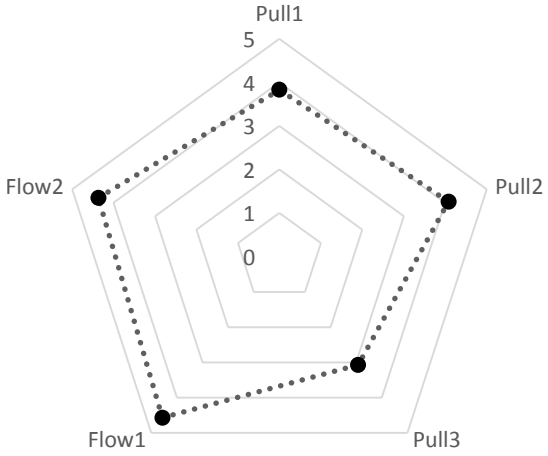

Figure 3. Averages of implementations of practices in the area of "pull and flow processes" in the surveyed companies.

Source: Own work.

Based on the obtained results, it is suggested to focus on further improving the Pull2 practice, despite its high rating, to increase its standardized factor loading. This will allow for a more precise assessment of the impact of this practice on the overall efficiency of the pull system. Additionally, it is worthwhile to undertake a detailed analysis of practices in the "flow" processes area, identifying areas where improvements can be introduced to enhance their consistency with lean principles.

Maintenance is another key element of LM. It allows for the maintenance of the efficiency and reliability of machinery and equipment, which is essential for ensuring effective production (Czerska, 2014; Furman, 2014).

The implementation of the "Maintenance" dimension (Total Productive Maintenance - TPM) in the surveyed enterprises was positively evaluated by the respondents. The average rating was 4,06, and the low standard deviation (0,97) suggests consensus in the respondents' assessments. The highest average score was obtained for the TPM2 factor, which pertains to the regular maintenance of the entire production equipment. On the other hand, the lowest rating was given to the TPM3 factor, related to meticulous documentation of equipment maintenance (see Table 5 and Figure 4).

The ratings of individual components are close to each other, indicating a consistent assessment of various aspects of maintenance in the surveyed enterprises. All components of the TPM construct show significant correlations, confirming consistency in the perception and evaluation of respondents regarding equipment maintenance.

TPM3 has the highest factor loading, suggesting that meticulous documentation related to equipment maintenance is particularly important in the context of TPM assessment. However, it is worth noting that all standardized factor loadings within the TPM construct are at a level equal to or higher than 0,3, confirming the significant importance of each element of the construct.

Table 5.
Maintenance (TPM)

Characteristics	$\bar{x}$	σ	Standardized Factor Loadings	The average correlations of the component with the remaining variables
We dedicate part of our daily activities to planned equipment maintenance (TPM1)	3,92	1,23	0,387	0,285
We regularly maintain all our production equipment (TPM2)	4,35	0,62	0,547	0,359
We maintain meticulous documentation of all activities related to equipment maintenance (TPM3)	3,90	0,91	0,927	0,433

Source: Own work.

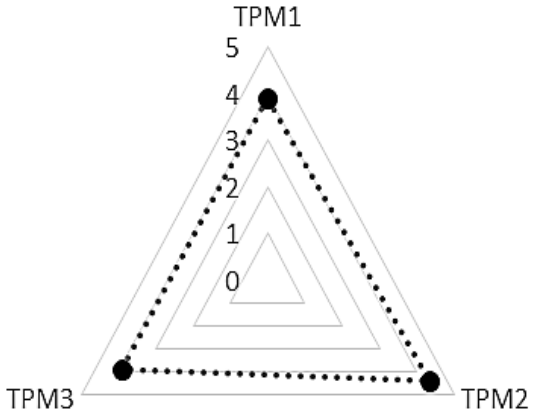

Figure 4. Averages of implementations of practices in the area of "Total Productive Maintenance (TPM) maintenance" in the surveyed companies.

Source: Own work.

The research results suggest that companies should focus on further developing maintenance practices. In particular, they should concentrate on the following areas:

1. Implementation of a preventive maintenance system: Currently, the surveyed companies focus on corrective maintenance, which is carried out only after a breakdown occurs. Implementing a preventive maintenance system would prevent breakdowns and ensure greater reliability of machinery and equipment.
2. Implementation of a maintenance documentation management system: Currently, maintenance documentation is often managed in a disorganized and inefficient manner. Implementing a maintenance documentation management system would organize the documentation and facilitate access to it.

In the context of the contemporary business environment, where dynamic changes and competition present numerous challenges to companies, there is a growing understanding of the role that internal relationships play in the context of employee engagement and continuous improvement. According to the results of the conducted study, it has been confirmed that good relationships within a company are crucial for increasing employee engagement and reducing their resistance to change.

In the area of "employee engagement," consisting of seven dimensions, the surveyed companies obtained an average rating of 4,10, with a low standard deviation of 0.87. This suggests consistency in the respondents' assessments, which are closely aligned. The practice P1 is most correlated with the other dimensions, and the highest factor loadings are for P1, P3, and P7 (see Table 6).

Table 6.
Employee Engagement

Characteristics	$\bar{x}$	σ	Standardized Factor Loadings	The average correlations of the component with the remaining variables
The majority of production hall employees are cross-trained (P1)	4,02	0,93	0,599	0,259
Operational employees are actively engaged in continuous improvement activities and have the authority to implement changes (P2)	3,69	0,91	0,323	0,146
The work environment is organized in a way that most tasks are performed in teams (P3)	3,99	0,93	0,593	0,249
Employees regularly submit individual and team ideas for improvement (P4)	3,90	0,80	0,431	0,202
Leadership is involved in quality-related training (P5)	4,42	0,69	0,326	0,163
All employees are encouraged to submit suggestions for problem-solving (P6)	4,55	0,56	0,483	0,253
A structured employee training program is implemented and adhered to (P7)	4,15	0,60	0,506	0,240

Source: Own work.

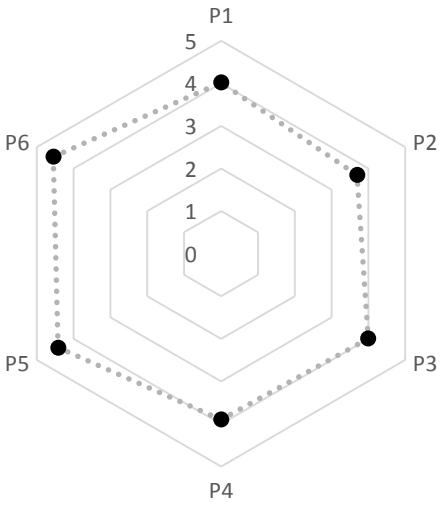

Figure 5. Averages of implementations of practices in the area of "Employee Engagement" in the surveyed companies.

Source: Own work.

In respect to the obtained results, companies, guided by the idea of continuous improvement, are aware of the importance of the right approach to internal relational capital. Introducing new products, maintaining production efficiency in small batches, and minimizing production costs become challenges that companies seek to address by investing in human capital.

Effective employee engagement becomes a key element in achieving the success of a company. Employees who feel like an integral part of the organization are more inclined to actively participate in the process of continuous improvement, translating into improved results. The study results, indicating an average rating of 4,10 in the area of employee engagement, underscore the significant role of this relationship for the effective functioning of an organization.

The research results indicate that companies should focus on further developing employee engagement. Specifically, they should concentrate on the following areas:

- Implementation of a motivational system that rewards employees for their engagement. Currently, most companies rely on a reward-based motivational system. However, there are many other ways to motivate employees, such as recognition, training, and professional development opportunities.
- Creating an organizational culture that supports employee engagement. Organizational culture should promote openness, communication, and collaboration. Employees should feel appreciated for their contributions and have a sense that their opinions are taken into account.
- Involving employees in decision-making processes. Employees should be actively engaged in decision-making processes that affect them. This will allow them to feel that they have an impact on their work and that their opinions matter.

To assess the measurement tool, a reliability evaluation of the model was conducted before proceeding with statistical analyses, utilizing, among others, the Cronbach's Alpha coefficient, which simultaneously serves as an assessment of the internal consistency of the research tool. Measurement scale checks were performed for the following variables: supplier relationships, customer relationships, "pull" and "flow" processes, Total Productive Maintenance (TPM), and employee engagement. The results of the study are presented in Table 7.

Reliability assesses the degree of consistency between multiple measurements of a variable (Hair et al., 1988). In this study, the reliability of the scale is measured in terms of the agreement of results obtained for the observed variables, primarily using the Cronbach's Alpha coefficient. This coefficient is calculated as the average intercorrelations between items measuring the concept (Sekaran, 2003). The closer the coefficient is to unity, the higher the internal consistency and reliability of the study. As observed, not all constructs have α values higher than 0.6, suggesting that the internal consistency and reliability of the study regarding "pull" and "flow" processes and TPM maintenance are questionable.

Table 7.
Reliability Analysis Coefficients of Constructs Examining the Implementation Level of Lean Management

Area	Number of Questions	Cronbach's Alpha	Cronbach's Alpha based on standardized items	Lambda 4	Composite Reliability
Supplier Relationships	7	0,73	0,75	0,84	0,74
Customer Relationships	5	0,68	0,74	0,78	0,75
Processes: "Pull" and "Flow"	5	0,53	0,51	0,61	0,53
Maintenance (TPM)	3	0,58	0,63	0,56	0,67
Employee Engagement	7	0,65	0,66	0,74	0,66

Source: Own work.

The analyzed study was conducted among numerous respondents evaluating various contexts with different interpretations, hence Cronbach's Alpha may not assume the required values. M. Schrepp (2020) suggests providing correlations of individual items (variables of a given construct) whenever possible. This allows for a much better insight into the scale's consistency. Incorrect interpretations of individual items are clearly visible through small correlations with other items of the scale, which can then be considered in the data interpretation.

Therefore, the reliability analysis was supplemented with indicators: Cronbach's Alpha based on standardized items, Lambda 4 - Guttman's split-half coefficient, and the composite reliability coefficient.

It should be stated that the reliability analysis of the developed measurement tool in the area of verifying the implementation status of LM confirms its suitability for empirical verification of the state of lean implementation.

In this study, the second-order latent variable LM was generated using a reflective construct model. This type of modeling is perceived as one in which all first-order latent variables are correlated.

Table 8 illustrates the correlations between first-order latent variables (lean practices). Among the 10 possible correlations, only one is not statistically significant at the assumed significance level of $p<0,05$, indicating the possibility of the existence of a higher-order latent variable.

Table 8.
Spearman correlation coefficients indicating the degree of dependence between adopted Lean Management constructs

	DS	K	PULL/FLOW	TMP	P
DS	1				
K	0,256 (p=0,004)	1			
PF	0,404 (p<0,001)	0,090 (p=0,314)	1		
TMP	0,223 (p=0,011)	0,414 (p<0,001)	0,248 (p=0,005)	1	
P	0,257 (p=0,003)	0,240 (p=0,006)	0,309 (p<0,001)	0,395 (p<0,001)	1

$0,0 \leq |r| \leq 0,2$ - no correlation
$0,2 < |r| \leq 0,4$ - weak correlation
$0,4 < |r| \leq 0,7$ - moderate correlation
$0,7 < |r| \leq 0,9$ - strong correlation
$0,9 < |r| \leq 1,0$ - very strong correlation

Source: Own work.

The analyzed data simultaneously suggest that the surveyed companies have a narrow view of the Lean Management concept, implementing LM practices in a fragmented manner. This confirms results obtained in other, earlier studies.

5. Summary

Summarizing the research results, it can be concluded that LM is widely implemented in Polish manufacturing companies. Practices in the "Customer Relations" and "Employee Engagement" areas are particularly well-developed. Focusing on building close relationships with customers, involving them in product development processes, and conducting systematic customer satisfaction surveys has yielded positive results.

However, it should be noted that areas such as "Supplier Relations" and "Processes: Pull and Flow" require further action in implementing lean practices. Despite certain areas for development, the research results confirm that LM is an effective management strategy, generating benefits in terms of improving customer relations, employee engagement, and process efficiency.

The conclusions drawn from the conducted research are of significant importance for management practice, suggesting that LM constitutes a solid foundation for manufacturing companies. The achieved goal of the article, i.e., assessing the implementation of Lean Management in Polish firms, provides valuable information for managers and decision-makers, encouraging them to continue their efforts towards effective implementation of this management strategy.

Based on the conducted research, the following conclusions can be drawn:

- The implementation of LM in Polish manufacturing companies is at a relatively high level.
- The areas of "customer relations" and "employee engagement" are the best implemented.
- In the case of the "supplier relations" area, the results are slightly lower, and in the case of the "processes: pull and flow" area, they are the lowest.
- The areas of "supplier relations" and "processes: pull and flow" require further action in the implementation of lean practices.

The significance of the research results for management practice is substantial. The findings indicate that LM is an effective management strategy that can bring tangible benefits to manufacturing companies. The implementation of LM allows for the improvement of customer relations, employee engagement, and process efficiency, which can translate into increased competitiveness for the company.

To further develop Lean Management in Polish manufacturing enterprises, it is necessary to:

- increase managers' awareness of the benefits of LM,
- train employees in the field of LM,
- develop and implement lean development plans in enterprises.

An additional value of the article is the proposal of a measurement tool for diagnosing the state of LM implementation divided into five constitutive areas for LM.

Interpreting the research results, one must consider its limitations. Only one respondent from each company participated in the survey. As a result, it is unknown whether the views of the respondent are shared by other members of the organization. Moreover, bias resulting from the respondent's position, length of employment, or scope of knowledge cannot be ruled out. At the same time, the study is cross-sectional, which does not allow for causal inferences and may be subject to measurement errors. The obtained results may also be affected by systematic error since the same respondent provided indications regarding exogenous and endogenous variables. It should also be noted that the sample selection is not random, as the respondents represented only those companies for which there was certainty about the implementation of the Lean Management concept.

From the limitations, certain future directions for further research can be inferred, which, according to the author, should primarily include the study of barriers to the diffusion of Lean Management strategies and research that would allow explaining the impact of situational factors, especially the SARS-CoV-2 (COVID-19) pandemic, on the adoption of LM methods by companies in the longer time perspective.

References

1. Cyfert, S. (2012). *Granice organizacji.* Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu
2. Czarnecki, J.S., (2010). *Zarządzanie jako nadawanie sensu kombinacji zasobów*. In: I. Sobańska (ed.), *Rachunkowość zarządcza. Podejście operacyjne i strategiczne* (pp. 19-72). Warszawa: C.H. Beck.
3. Czerska, J. (2014). *Podstawowe narzędzia Lean Manufacturing.* Gdańsk: Lean QTeam.
4. Furman, J. (2014). Wdrażanie wybranych narzędzi koncepcji Lean Manufacturing w przedsiębiorstwie produkcyjnym. *Innowacje w zarządzaniu i inżynierii produkcji*, *1*, 247-256.
5. Gendo, F., Konschak, R. (1999). *Mythos Lean Production: die wahren Erfolgskonzepte japanischer Unternehmen.* Verlag Betrieb und Wirtschaft.
6. Gil-Vilda, F., Yagüe-Fabra, J.A., Sunyer, A. (2021). From lean production to lean 4.0: a systematic literature review with a historical perspective. *Applied Sciences*, *11*(21), 10318.
7. Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C. (1988). *Multivariate data analysis.* New Jersey: Prentice-Hall.
8. Hicks, B.J. (2007). Lean information management: Understanding and eliminating waste. *International Journal of Information Management*, *27*(4), 233-249.
9. Hines, P., Holweg, M., Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking, *International Journal Of Operations & Production Management*, *24*(10), 994-1011.
10. Hutchinson, R., Liao, K. (2009). Zen accounting: how Japanese management accounting practice supports lean management. *Management Accounting Quarterly*, *11(1)*, 27-35.
11. Kennedy, F.A., Brewer, P.C. (2005). Lean accounting: what's it all about? *Strategic Finance*, *87*(5), 26-34.
12. Kleszcz, D., Zasadzień, M., Ulewicz, R. (2019). Lean Manufacturing in the ceramic industry. *Multidisciplinary Aspects of Production Engineering*, *2*(1), 457-466.
13. Liker, J. (2005). *Droga Toyoty. 14 zasad zarządzania wiodącej firmy produkcyjnej świata*. Warszawa: MT Biznes.

14. Liker, J., Ross, K. (2017). The Toyota way to service excellence. *Lean transformation in service organizations.* Yhdysvallat: McGraw-Hill Education.
15. Łyszkowska, E. (2022). Application of the Lean Management methodology in Polish companies. *International Journal of New Economics and Social Sciences (IJONESS)*, *16*(2), 83-92.
16. Niewiadomski, P., Oleśków-Szłapka, J. (2017). *The assessment of implementation of the lean strategy within manufacturing companies in agricultural machinery sector*. DEStech Transactions on Engineering and Technology Research, 24th International Conference on Production Research, pp. 63-68.
17. Nogalski, B., Niewiadomski, P. (2017). Kształtowanie partnerstwa z kluczowymi klientami–próba oceny poziomu elastyczności działań. *Studia Ekonomiczne*, *322*, 121-137.
18. Nogalski, B., Walentynowicz, P. (2007). Lean management, jako koncepcja podwyższania bezpieczeństwa ekonomiczno-finansowego firmy. In: M. Grzybowski, J. Tomaszewski (ed.), *Bezpieczeństwo w administracji i biznesie* (pp. 279-286). Gdynia: Wyższa Szkoła Administracji i Biznesu im. Eugeniusza Kwiatkowskiego w Gdyni.
19. Nowotarski, P., Paslawski, J. (2018). Lean management in small and medium-sized construction enterprises in Poland-selected results. *Przegląd Naukowy. Inżynieria i Kształtowanie Środowiska*, *27*(3[81]).
20. Nunnally, J. (1978). *Psychometric methods.* New York: McGraw Hill.
21. Pawłowski, E., Pawłowski, K., Trzcieliński, S. (2010). *Metody i narzędzia Lean manufacturing: materiały dydaktyczne*. Poznań: Wydawnictwo Politechniki Poznańskiej.
22. Piasecka-Głuszak, A. (2013). Poprawa innowacyjności i konkurencyjności polskich przedsiębiorstw przez zastosowanie koncepcji lean management. *Finanse, Rynki Finansowe, Ubezpieczenia, 57*.
23. Psomas, E., Antony, J. (2019). Research gaps in Lean manufacturing: a systematic literature review. *International Journal of Quality & Reliability Management*, *36*(5), 815-839.
24. Putnik, G. (2012). Lean vs agile from an organizational sustainability, complexity and learning perspective. *The Learning Organization*, *19*(3), 176-182.
25. Saudi, M.H.M., Juniati, S., Kozicka, K., Razimi, M.S.A. (2019). Influence of lean practices on supply chain performance. *Polish journal of management studies, 19*.
26. Schrepp, M. (2020). On the Usage of Cronbach's Alpha to Measure Reliability of UX Scales, *Journal of Usability Studies*, *15*(4).
27. Sekaran, U. (2003). *Research methods for business, a skill building approach*. New York: John Wiley.
28. Shah, R., Ward, P.T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, *21*(2), 129-149.
29. Shah, R., Ward, P.T. (2007). Defining and developing measures of lean production. *Journal of Operations Management*, *25*(4), 785-805.
30. Shook, J. (2007). *Lean production simplified*. Productivity Press.

31. Sinha, N., Matharu, M. (2019). A comprehensive insight into Lean management: Literature review and trends. *Journal of Industrial Engineering and Management (JIEM), 12*(2), 302-317.
32. Stronczek, A. (2022). *Szczupła rachunkowość zarządcza w polskich przedsiębiorstwach produkcyjnych.* Kraków: Wydawnictwa AGH.
33. Tarka, P. (2017). *Uwarunkowania skuteczności badań marketingowych*. Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
34. Trzcieliński, S. (2011). *Przedsiębiorstwo zwinne.* Poznań: Wydawnictwo Politechniki Poznańskiej.
35. Ulewicz, R., Czerwińska, K., Siwiec, D., Pacana, A. (2022). Analysis of the systemic approach to the concept of lean manufacturing–results of empirical research. *Polish Journal of Management Studies, 25*(2), 375-395.
36. Walentynowicz, P. (2013). *Uwarunkowania skuteczności wdrażania Lean Management w przedsiębiorstwach produkcyjnych w Polsce*. Wydawnictwo Uniwersytetu Gdańskiego.
37. Wiśniewska, M. (2005). Jak - czyli Kaizen odpowiada na potrzeby. Osiągnięcie efektywnych procesów całej organizacji jest możliwe. Czy Kaizen pozwala osiągnąć ten cel. *Zarządzanie Jakością, 1*, 24-27.
38. Womack, J.P., Jones, D.T. (2003). *Lean Thinking*. *Banish waste and create wealth in your Corporation.* New York: Free Press.
39. Womack, J.P., Roos, D., Jones, D.T. (1990). *The Machine that Changed the World*. New York: Rawson Associates.