



The Use of Lean Tools in the Food Industry

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Abstract. Lean, as a concept focused on eliminating waste, optimizing processes, and creating customer value, has enjoyed widespread applications across numerous industries. However, its effective implementation requires adaptation to the specific characteristics of a given sector and enterprise. This article presents an evaluation and analysis of the use of Lean Management and selected Lean tools in an enterprise operating in the food industry. Based on a structured literature review, the paper outlines the origins, fundamental assumptions, and key tools associated with Lean Manufacturing. Subsequently, an empirical study based on a questionnaire survey was conducted among employees of a food industry company that has been applying the Lean Management concept for several years and systematically uses a range of Lean tools to optimize and improve its processes. The findings provided the basis for the formulation of conclusions confirming the applicability and effectiveness of the Lean Management approach in the food industry, as well as for identifying and evaluating the extent of the use of individual Lean tools. The results may serve as a starting point for further research and support practical implementations of Lean in food industry enterprises.

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1. INTRODUCTION

Modern enterprises operating within the food industry function in a highly dynamic and increasingly competitive environment in which operational efficiency, organizational flexibility, and the capacity for rapid adaptation constitute critical determinants of long-term competitiveness. The sector is characterized by pronounced

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demand variability, strong seasonality, short product shelf life, and stringent regulatory requirements related to food quality and safety. These conditions, combined with intense market pressure, compel food industry organizations to continuously seek management approaches that enable them to maintain market position, enhance operational performance, and respond effectively to evolving customer expectations.

One of the management concepts that has gained substantial relevance in addressing these challenges is Lean. This approach emphasizes the systematic elimination of waste, the optimization of process flows, and the enhancement of customer value creation. Originally developed in Japan in the 1950s within the Toyota Motor Corporation, Lean Management became widely known and formally conceptualized through the work of researchers at the Massachusetts Institute of Technology (MIT) in the 1990s. Since then, the concept has been continuously expanded, refined, and successfully implemented across a wide spectrum of industries and organizational contexts worldwide.

Although the origins of Lean Management are closely associated with the automotive sector, its methodological foundations – particularly the focus on value stream analysis, waste reduction, and continuous improvement – have proven transferable to numerous other industries. Consequently, a growing number of food industry enterprises have begun integrating Lean principles into their operational and strategic management practices.

Despite the growing number of studies addressing the implementation of Lean in the food industry, much of the existing literature remains descriptive in nature, focusing on cataloguing applied tools or reporting general performance improvements. Less attention has been devoted to understanding *how* Lean tool portfolios evolve over time in organizations with long-term Lean experience.

In particular, there is limited empirical insight into Lean adoption from the perspective of operational employees in mature Lean environments, especially within sectors characterized by strict regulatory requirements. These sector-specific conditions may significantly shape managerial decision-making regarding the selection, prioritization, and sustained use of Lean tools.

2. LEAN CONCEPT

The origins of Lean are closely connected with the history of Toyota, one of the most recognizable brands in the world. The foundation for the creation of the Toyota Production System (TPS), the production system that later became the basis for Lean Management, was the technological heritage of the Toyoda family. Kiichiro Toyoda travelled across Europe and the United States, where he observed the rapidly developing automotive industry of the 1920s. Recognizing the potential of this emerging sector, he sold the patent rights to the automatic loom and invested the proceeds in the development of an automotive company. In this way, Toyota Motor Company was established in 1937. The creators of the TPS system, which emerged in the 1950s, are considered to be Eiji Toyoda and Taiichi Ohno.

The concept of the Toyota Production System (TPS) was popularized in 1990 by researchers from the Massachusetts Institute of Technology (MIT) – James Womack, Daniel Jones and Daniel Ross – through their publication *The Machine That Changed the World: The Story of Lean Production* (Womack et al., 2007), which presented extensive benchmarking studies on quality and productivity differences among automotive plants worldwide. The term Lean Production itself was first used by John Krafcik in 1988 to describe a form of mass production (Krafcik, 1988); Krafcik was also a member of the MIT research team. The term can be understood as “lean production,” referring to the significant reduction of resources, labor, space, tools, and production time used. As the concept of Lean Manufacturing was initially focused on improving production process efficiency, additional terms such as Lean Thinking and Lean Management emerged, emphasizing the efficiency of the organization as a whole – including both production and service processes (Soliński, 2019).

The concept rapidly gained global popularity and began to be successfully implemented in manufacturing and service enterprises, as well as in public sector organizations.

This methodology has been extensively described in numerous works, including *The Machine That Changed the World* (Womack et al., 2007), *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (Womack & Jones, 2012), and *The Toyota Way: 14 Management Principles from the World’s Greatest Manufacturer* (Liker, 2004). Lean Management is a method of managing an enterprise whose primary objective is to introduce lean practices across all dimensions of organizational functioning. It focuses on consistently minimizing waste in all areas of activity – not only within internal operations, but across the entire supply chain – where customers, their needs, and expectations occupy a central role. Waste refers to any activity that consumes resources but does not generate value. These activities are described by the Japanese term *muda*, comprising seven categories of waste identified by Taiichi Ohno. The primary types of waste include overproduction, waiting, transportation, overprocessing, inventory, motion, and the production of defects (Ohno, 2008). Additional categories include blaming, underutilization of employee potential, and lost opportunities (Sigmology).

The concept of Lean involves, among other things, simplifying process operations, eliminating unnecessary activities, accelerating process flow, and minimizing operational costs and resource consumption – while ensuring that such changes do not hinder the delivery of products or services of the highest quality to the customer.

Lean Management is particularly suited for managers who are oriented toward long-term objectives and possess a clear strategic vision for their enterprise (Womack & Jones, 2012). Managers are responsible for creating an organizational culture focused on high process quality (“right first time”) and continuous identification of problems and opportunities for improvement (Liker, 2016). Soliński (2019) notes that both Lean and Six Sigma aim to improve processes by eliminating waste and identifying root causes. In practice, however, Lean emphasizes flow and waste elimination, whereas Six Sigma focuses on statistical control and the reduction of process variability.

The literature provides evidence that the implementation of Lean is associated with improved business performance (Fullerton et al., 2003). Empirical research

indicates that Lean practices are applied across a diverse range of organizations (Kollberg et al., 2007; Soriano-Meier & Forrester, 2002). However, scholars also highlight the need for further research to fully understand the impact of Lean Manufacturing on organizational performance (Cua et al., 2001; White & Prybutok, 2001; Liu et al., 2021). Studies show that implementing Lean Management enables organizations to attain numerous benefits, including increased productivity, reduced cycle time, reduced production space, decreased work-in-process inventory, shorter lead times, improved working conditions, and enhanced quality.

In this paper, Lean Management is understood as a comprehensive managerial philosophy encompassing organizational culture, leadership practices, and continuous improvement across the entire value stream, while Lean Manufacturing refers specifically to the application of Lean principles and tools within production operations. Although closely related, these concepts are not synonymous and operate at different levels of organizational analysis.

The empirical part of this study focuses primarily on Lean Manufacturing practices embedded within a broader Lean Management system.

3. LITERATURE REVIEW – THE APPLICATION OF LEAN TOOLS IN THE FOOD INDUSTRY

Today, Lean is understood as a management philosophy based on coherent principles, methods, and techniques that collectively form a comprehensive organizational system. The foundation of Lean are the five principles formulated by Womack and Jones (Womack et al., 2007):

- **Specify Value** – clearly identifying which processes and operations generate value from the customer’s perspective,
- **Identify the Value Stream** – mapping and classifying all activities necessary in the production process as well as those constituting waste,
- **Ensuring Continuous Flow** of processes and materials – modifying the flow of value to eliminate disturbances,
- **Implementing a Pull System** – producing according to actual demand, meaning responding directly to customer requirements,
- **Pursue Perfection** through continuous improvement and organizational learning.

These principles form the basis of an organizational culture founded on employee engagement, transparency, and process self-control (Liker, 2004). They can be applied not only to production processes but also to administrative, logistics, and service operations, which makes Lean a universal approach.

While Lean principles define the conceptual foundation, Lean tools represent their practical implementation – a set of techniques that support the application of Lean in real processes. These methods support the core objectives of Lean: eliminating waste, ensuring smooth process flow, improving quality, and engaging employees in continuous improvement. Table 1 presents a brief overview of these tools and their applications within the food industry.

Table 1. *Lean methods – characteristics and possible applications in the food industry*

Lean Method	Description	Application in the Food Industry
Value Stream Mapping (VSM)	A tool for diagnosing and designing the value stream, enabling identification of waste within the process	Analysis of holding times, raw material flow and quality risks
Just-in-Time (JIT)	A method for synchronizing production with actual demand, minimizing inventory and lead times	Minimizing fresh product inventory and improving SKU rotation
Heijunka	A method for leveling production to reduce workload fluctuations and overproduction	Stabilizing the production plan under raw material seasonality
Kanban	A visual system for controlling the flow of materials and information in a pull system	Controlling raw material deliveries and flow between production stages
Jidoka	Autonomation principle – stopping the process when a defect is detected	Automatic detection of deviations, packaging defects and quality parameters
Poka-Yoke	Error-proofing method using simple technical safeguards	Reducing dosing, labelling and machine-setting errors
TPM	A method for building machine reliability through operator involvement	Ensuring line continuity and minimizing cleaning-related downtime
SMED	A method for reducing machine changeover times	Fast changeovers between different SKUs and production batches
5S	A workplace organization and standardization method based on order and visual control	Maintaining hygiene, cleanliness and HACCP compliance
Kaizen	A method of small, continuous improvements	Systematic elimination of waste, errors and unnecessary activities
Standardized work	A method for maintaining the best-known way of performing operations	Stabilizing processes in high sanitary-requirement environments

The literature review indicates that Lean implementation in the food industry is primarily motivated by six factors: process-variability reduction, waste elimination, increased competitiveness, cost reduction, inventory-level reduction, and enhanced process efficiency (Costa et al., 2018). Food industry enterprises employ a range of tools derived from the Lean Management concept. The most frequently used Lean tools include value stream mapping (VSM), root-cause analysis (RCA), 5S, brainstorming, Pareto diagrams, process mapping, and visual management (Costa et al., 2018; 2021). The use of Total Productive Maintenance (TPM) is also popular (Dora et al., 2013; 2014). The application of these tools within the food sector is presented in Table 2.

Table 2. *Overview of Lean tools used in the food sector*

Tool	Application Context	Study / Authors
Value Stream Mapping (VSM)	Visual representation of process flow to identify waste (non-value-added activities)	Jiménez et al. (2011); Ramlan et al. (2017); Vlachos (2015); Widiwati et al. (2025)
5S	Systematic workplace organization supporting waste elimination and Kaizen culture	Soliński & Omyła (2021); Widiwati et al. (2025) Domínguez et al. (2021)
Standardized Work	Ensures consistent and repeatable execution of tasks; includes checklists	Soliński & Omyła (2021); Widiwati et al. (2025)
SMED	Reduces changeover time between product batches	Jiménez et al. (2011); Widiwati et al. (2025)
Kaizen	Continuous improvement philosophy applied through incremental changes	Soliński & Omyła (2021)
Pareto Chart	Identifies key defects or waste sources (80/20 rule)	Widiwati et al. (2025);
Visual Management	Use of labels, markings and visual cues for monitoring standards	Soliński & Omyła (2021)
TPM	Focuses on preventing equipment downtime through preventive maintenance	Dora et al. (2013)

As a result of implementing the Lean concept and applying Lean tools, the food industry has reported numerous benefits. In the implementation studies conducted by Costa et al. (2018), thirty-one distinct benefits were identified. These benefits included, among others, increased productivity, cost reduction, inventory reduction, increased machine availability, improved financial performance, waste reduction, shorter lead times, and enhanced process capability.

Dora et al. (2014), examining European food industry enterprises, likewise demonstrated that the most significant benefits of Lean implementation in this sector are cost-related improvements (cost reduction, increased profitability, and increased productivity).

Although prior studies confirm that Lean tools such as 5S, VSM, TPM, and SMED are applicable in food industry settings, the literature rarely explains differences between their initial implementation and long-term institutionalization. Most studies report implementation outcomes, while fewer examine contextual constraints that limit the sustained use of analytically demanding tools, such as VSM, SMED or TPM, in highly regulated and capacity-constrained environments.

This gap suggests a need for research that goes beyond tool adoption rates and examines how sector-specific characteristics – such as hygiene regimes, audit pressure, production continuity requirements, and workforce structure – shape managerial and operational preferences for certain Lean practices over others.

4. RESEARCH METHODOLOGY AND RESEARCH OBJECTIVE

A questionnaire survey was used in the study and distributed to employees of a selected large food industry enterprise – an organization that has applied the Lean Management concept in its production processes for many years. The use of a questionnaire as the research instrument enabled the collection of employees' opinions, experiences, and assessments regarding the implementation of Lean and the use of Lean tools in everyday work. This made it possible to obtain a more comprehensive view of the functioning of the process improvement system from the perspective of individuals directly involved in operational activities.

The study was conducted in 2024, and the questionnaire was made available to employees electronically, with full anonymity of responses ensured. The survey consisted of 18 closed-ended questions, some of which were assessed using a five-point Likert scale, where respondents indicated their level of agreement or disagreement with specific statements (from 1 – “strongly disagree” to 5 – “strongly agree”).

The questionnaire included questions concerning:

- awareness and understanding of Lean principles,
- practical use of Lean tools,
- evaluation of the impact of Lean tools on process efficiency,
- identification of benefits resulting from the use of Lean tools,
- difficulties and barriers related to the use of Lean tools and the implementation of Lean practices.

The quantitative analysis of the responses allowed for determining the degree of implementation of individual Lean tools in the examined organization, identifying the key factors influencing their effectiveness, and assessing the overall readiness of the enterprise for further development of the Lean Management concept.

A total of 34 individuals participated in the study, representing approximately 40% of all production employees. The sample consisted of operators (53%), leaders (23.5%), and supervisors/managers (23.5%). In the examined company, more than one-third of respondents had been employed for over 10 years (35%), while 41% had between 3 and 10 years of service. Employees with less than 3 years of tenure accounted for 24% of the sample and were primarily operators.

5. DISCUSSION OF RESEARCH FINDINGS

Lean is understood nowadays as a management philosophy based on coherent principles, methods, and techniques that collectively form a comprehensive organizational system. The foundation of the concept of Lean are the five principles formulated by Womack (Womack et al., 2007).

The results of the analysis indicate that 100% of the surveyed employees are aware that the company applies the Lean concept and are familiar with its fundamental principles. All respondents reported participating in regular Lean training sessions.

All participants also stated that they use selected Lean tools in their daily activities. The degree of use of individual tools is presented in Figure 1. The results suggest that the concept of standardized work is deeply embedded in the organizational culture. All respondents (100%) indicated that they apply standard work and 5S. Additionally, a high proportion reported using OPL (94%) and visual management (74%) in their daily work. The next most frequently applied Lean tools were Kaizen, SMED, VSM, TPM, Gemba Walk, RCA, Pareto analysis, and PDCA (Fig. 1).

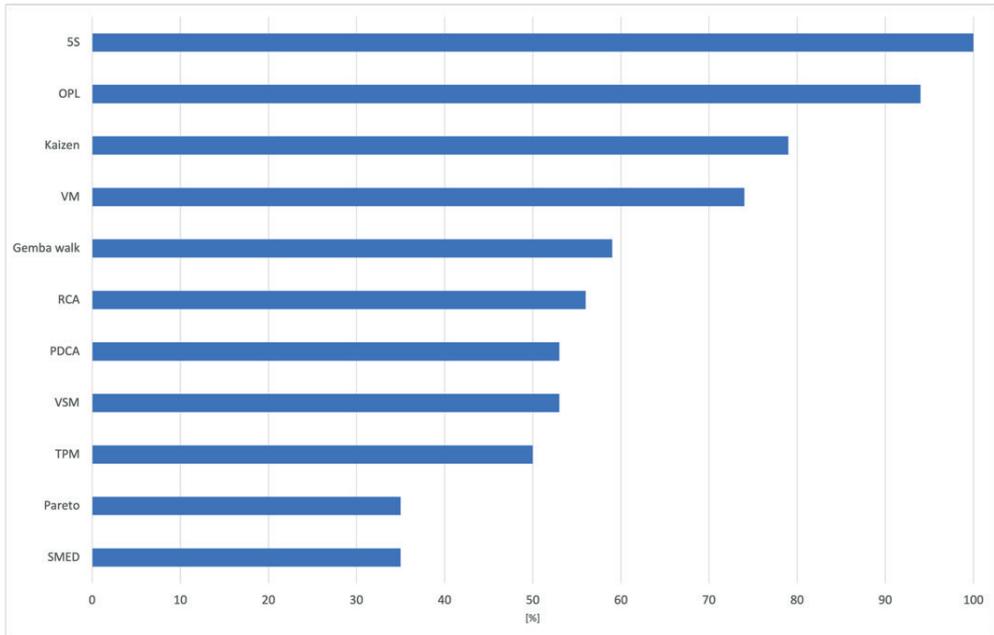


Fig. 1. Level of use of individual Lean tools

The results reveal a clear asymmetry in the use of Lean tools within the examined enterprise. Foundational tools such as standardized work and 5S are fully implemented, while more advanced analytical tools – such as VSM, SMED, TPM, and Pareto analysis – remain comparatively underutilized despite long-term Lean adoption.

This pattern can be interpreted in light of the specific operational constraints of food production. Standardized work and 5S directly support hygiene compliance, audit readiness, and process repeatability, which are critical under HACCP and food safety regulations. Their widespread use reflects not only Lean maturity, but also alignment with regulatory requirements.

From a managerial perspective, the findings suggest that Lean implementation in the food industry is less about the universal deployment of all tools and more about strategic prioritization. Managers appear to favor tools that ensure operational sta-

bility, visual control, and compliance, even if this limits the use of more sophisticated improvement methodologies.

The assessment of the impact of Lean tools on work efficiency shows that 79.4% of respondents evaluated this impact positively (38.2% assessed it as highly positive, stating that Lean tools significantly improve work efficiency; 41.2% assessed the impact as positive – indicating that improvement is noticeable but not substantial). A neutral impact was indicated by 17.6% of respondents, while 2.9% assessed the impact of Lean tools on daily work efficiency negatively.

The effects of using Lean tools were further examined through questions regarding their usefulness in identifying and eliminating waste in processes (50% of respondents strongly agreed, 47% agreed, and 3% had no opinion) as well as through the statement that Lean contributes to achieving organizational objectives (62% strongly agreed, 35% agreed, and 3% had no opinion).

Employees also identified a range of benefits (Table 3) and barriers and challenges (Table 4) associated with the implementation and use of Lean Management and its tools.

Table 3. *Benefits resulting from the use of Lean*

No.	Benefit	Percentage [%]
1	Cost optimization and waste reduction	97
2	Shortening project and process lead times	88
3	Improved safety and ergonomics	82
4	Improved product/service quality and customer satisfaction	76
5	Improved operational efficiency	73
6	Improved communication and cooperation between departments	70
7	Employee competence development	51
8	Increased employee engagement in improvement processes	49
9	Increased organizational flexibility	46

Table 4. *Barriers and difficulties in implementing Lean*

No.	Barrier / difficulty	Percentage [%]
1	Need for time and financial investment	91
2	Difficulty adapting to new work methods and tools	88
3	Employee resistance to change	85
4	Insufficient managerial support	50
5	Need for organizational culture change	50
6	Difficulties integrating Lean tools into daily processes	41
7	Lack of time for improvement activities	38

Taken together, the results presented in Tables 3 and 4 indicate that the perceived benefits of Lean implementation coexist with substantial organizational and behavioral constraints. While respondents clearly associate Lean practices with operational and cost-related improvements, the prominence of time-, resource-, and change-related barriers suggests that the effectiveness of Lean tools is shaped not only by their technical design, but also by the broader organizational context in which they are applied.

This simultaneous presence of clear benefits and persistent challenges appears to be a characteristic feature of mature Lean environments. Achieving positive performance outcomes does not eliminate structural and cultural tensions; instead, these tensions continue to coexist with improvement results. Consequently, Lean implementation in the examined enterprise should be understood as a continuous balancing effort between improvement opportunities and everyday operational constraints, rather than as a finished or stable condition.

6. CONCLUSIONS

The conducted study confirmed a high level of awareness of the Lean Management concept within the examined enterprise. All respondents (100%) declared familiarity with Lean principles and participation in regular process-improvement training sessions. This indicates a well-established organizational culture oriented toward continuous improvement and the dissemination of knowledge on Lean tools.

The analysis of the use of individual Lean tools showed that the most widely applied were standardized work and 5S (used by 100% of respondents), One Point Lesson (OPL) (94%), and visual management (74%). These results confirm that the organization has strongly embedded foundational tools that ensure order, clarity, and work standardization – forming the foundation of Lean implementation efforts.

Employees also reported the use of the following tools: Kaizen (79%), Gemba Walk (59%), Root Cause Analysis (RCA – 56%), VSM (53%), PDCA (53%), TPM (50%), SMED (35%), and Pareto analysis (35%). These findings suggest that, alongside foundational organizational tools, the company is also developing process-improvement methods, although more advanced approaches – such as VSM, SMED and TPM – are applied less frequently and less consistently.

The assessment of the impact of Lean tools on work efficiency was highly positive: 79.4% of respondents stated that Lean tools contribute to increased efficiency, of which 38.2% described this impact as “very positive.” This result confirms a high level of acceptance and perceived usefulness of the applied methods. Only 2.9% of respondents evaluated their impact negatively, which can be considered statistically marginal.

When assessing specific implementation effects, 97% of employees indicated that Lean supports waste reduction and cost optimization, while 88% confirmed its effectiveness in shortening process lead times. Significant benefits were also identified in the areas of workplace safety and ergonomics (82%), quality and customer satisfaction (76%), operational efficiency (73%), and interdepartmental communication

(70%). Benefits related to employee competence development (51%), engagement in improvement initiatives (49%), and increased organizational flexibility (46%) were indicated less frequently, suggesting that the “soft” and behavioral dimensions of Lean still require further development.

The identified barriers and challenges confirm that, despite a high level of Lean maturity, the organization continues to face difficulties in the sustained application of certain tools. The most significant obstacles included the need for time and financial investment (91%), difficulty adapting to new work methods (88%), and employee resistance to change (85%). Half of the respondents (50%) also indicated insufficient managerial support and the need to strengthen organizational culture, while 41% noted challenges in integrating Lean tools into daily processes, and 38% pointed to a lack of time for improvement activities.

The coexistence of high Lean awareness and significant resistance to change suggests that the identified barriers are not cognitive, but structural and organizational in nature. Employees may understand and accept Lean principles, yet still experience limitations related to time availability, workload, and insufficient managerial reinforcement.

The findings indicate that the enterprise has achieved a high level of Lean maturity in terms of conceptual understanding and use of essential tools. However, further development should focus on:

- enhancing the systematic and practical application of advanced methods (VSM, SMED, TPM, RCA),
- strengthening Lean leadership and the role of managers in sustaining a culture of continuous improvement,
- developing employees’ soft skills and a pro-improvement, innovation-oriented mindset,
- ensuring sufficient time and resources for regular and structured improvement activities.

This study is subject to several limitations. First, the research was conducted in a single food industry enterprise, which limits the generalizability of the findings. Second, the study is based on self-reported employee perceptions, without triangulation using objective operational performance indicators.

Future research should include comparative multi-case studies across different food subsectors, integrate quantitative performance data, and examine the longitudinal development of Lean tool portfolios. Further investigation into the interaction between Lean practices and food safety management systems may also provide valuable insights for both researchers and practitioners.

In summary, the study indicates that Lean in the examined organization is not merely a set of tools but a permanent component of its organizational culture. Nevertheless, fully leveraging its potential requires stronger managerial support, increased team engagement, and further development of practical skills related to process analysis and waste elimination. The results support the viability of Lean in the food industry, while highlighting the need for context-sensitive, sustained application rather than universal effectiveness claims.

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