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The role of a modern manager in shaping resilient supply chains using Lean Management tools

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Abstract. The research niche of this article is the relationship between Lean Management tools and supply chain resilience under uncertainty. The purpose is to synthesise how specific Lean instruments - value stream mapping (VSM), 5S, Kanban, just-in-time (JIT), Kaizen and Six Sigma - contribute to visibility,

flexibility, collaboration and robustness in logistics and transport enterprises and to clarify the manager's role in building a continuous improvement culture. The paper adopts the following research hypothesis (H1): consistent use of Lean tools, supported by managerial leadership and digital enablers, improves supply chain resilience by reducing process variability and enabling faster operational response to disruptions. The methodology combines a narrative literature review with a descriptive analysis of selected practical observations and reports from logistics companies in Lower Silesia and the Opole region (2022–2024). The synthesis indicates that flow-oriented tools (VSM, 5S, Kanban and JIT) shorten lead times and improve resource utilisation, while Kaizen and Six Sigma support quality and error reduction, translating into higher delivery reliability and lower damage rates. The conclusions emphasise that a modern manager's engagement, employee involvement and KPI-based monitoring are essential to sustain Lean, while digitalisation (TMS, IoT, analytics and AI/automation) enables realtime visibility and quicker process adaptations.

Keywords: logistics, Lean, supply chain, Kaizen, just-in-time

Introduction

Contemporary, dynamically changing conditions and the environment in which logistics operates necessitate a new outlook on many logistics activities and operations. Research and forecasting of changes have become a constant element of logistics operations. Therefore, from a broader scientific and research perspective, an inter-university research team focused on contemporary logistics issues and its optimisation conducts extensive analyses and studies on the functioning of modern logistics, particularly the execution of tasks within supply chains and networks. Assessing both current and future conditions of logistics operations makes it possible to identify certain directions and areas of change that will shape its functioning in the third and subsequent decades of the 21st century. This also provides the basis for modifying curricula and preparing courses and training programs precisely tailored to individual participants in contemporary global logistics processes and activities, which, with the highest possible probability, reflect the current state of affairs (specificity, conditions, limitations, etc.).

It should also be emphasized that the methodology that has so far relied on verification, evolution, and continuous adaptation is becoming increasingly less effective. There is a growing need to introduce comprehensive and innovative solutions that anticipate changes—not merely in terms of timing—because the world is changing very rapidly; what is effective today will not necessarily be an adequate or good solution tomorrow. Forecasting the development of logistics requires not only recognizing new conditions and challenges for logistics but also conducting a multifaceted analysis and understanding their mutual implementation and interactions. What will be the most significant determinants of these concepts and directions of evolution is difficult to define unequivocally—however, it is worth paying attention to several of them.

The article will present selected and significant elements that determine the implementation of international supply chains in the context of introducing the Lean concept. The conditions outlined in the article and their analysis form the

basis for optimizing operational processes, building adaptive solutions for modern logistics, and particularly for the functioning of international, global supply chains. To obtain valuable results, various quantitative and qualitative methods were applied. The research was based on a multifaceted analysis of the subject literature as well as a multidimensional exploration of descriptions and reports on the implementation of contemporary logistics activities. Special attention was given to the practical dimension of the research, with a thorough analysis and extensive use of the practical experiences of logistics companies from Lower Silesia and the Opole region, participants in international supply chains. It should be noted, however, that these studies were rather indicative and unsystematic. Nevertheless, their value is significant enough to serve as a foundation for the considerations presented in this article.

It is worth pointing out at this stage that the research on logistics processes in the aforementioned companies from Lower Silesia and the Opole region indicates that they currently lack a comprehensive method for identifying, quantifying, and assessing the effectiveness of executing assigned logistics tasks, as well as a model for implementing the Lean concept. As revealed by the research conducted among logistics process executors, all identified factors that could significantly influence the undertaken projects are very rarely considered and analysed by the implementers. Therefore, the identified gap justifies a study that links Leanbased process improvement with supply chain resilience and supports a more structured assessment of logistics performance under current and future operating conditions.

Accordingly, the aim of the study is to synthesise the contribution of Lean tools to supply chain resilience and to indicate managerial actions that enable effective implementation. The study tests hypothesis H1: consistent use of Lean tools, supported by managerial leadership and digital enablers, improves supply chain resilience by reducing process variability and enabling faster operational response to disruptions.

Lean in the enterprise

The Lean methodology, widely valued for streamlining operations and eliminating waste, is gaining increasing traction in the realm of global transport. In a rapidly evolving world, logistics enterprises face mounting pressures, such as rising costs, complex legal regulations, and ever-growing customer expectations. By implementing Lean concepts in logistics, businesses can not only boost productivity but also enhance customer service by reducing order fulfilment times and eliminating operational errors.

Lean is not limited to the manufacturing sector – it is a systemic approach that can be effectively applied throughout the entire value chain, including logistics and transport (Womack and Jones, 2003). One of the essential tools in this context is value stream mapping, which enables a detailed understanding of material and

information flows within the transport process. This facilitates the identification of bottlenecks and areas in need of improvement, such as delays in customs clearance.

Thus, Lean tools such as Value Stream Mapping, the continuous improvement process (Kaizen), and the implementation of the “just-in-time” philosophy contribute significantly to improving efficiency and strengthening market position. A key principle of Lean is the identification and elimination of waste. In international transport, this may involve issues such as suboptimal use of container space, unnecessary downtime, or inefficient communication between supply chain partners. Lean enables improvements in packing, loading, and route planning processes.

The application of value stream mapping in logistics, for example, reveals previously unnoticed sources of inefficiency and allows for their systematic elimination (Bicheno, Holweg, 2009). Implementing the “just-in-time” principle in global freight operations allows for precise product deliveries within designated timeframes, thereby reducing storage costs and potential losses related to damage.

In this light, transport enterprises that have adopted Lean are also better equipped to respond to dynamic market changes. A prime example is the rapid reconfiguration of routes in response to disruptions in global supply chains. The use of tools such as Kanban boards or the Kaizen philosophy facilitates resource management and coordination of workflow in a continuously changing logistics environment.

Average container and trailer utilisation

In recent years, the average utilisation of containers and trailers in international transport has emerged as a key indicator of efficiency in the logistics sector. Across the analysed time periods, significant transformations were observed, driven by global challenges such as disruptions in supply chains and evolving transport regulations. Demographic shifts further reshape supply readiness and risk exposure in supply logistics (Adamczyk, 2025).

In 2022, the average container fill rate hovered around 75%, largely as a result of the COVID-19 pandemic and the associated trade restrictions. By 2023, a degree of stabilization was noted, with the average utilisation reaching approximately 80%. This improvement can be attributed primarily to enhanced port throughput and more effective coordination within supply chains. This highlights that container efficiency is strongly dependent on the balance between demand and the availability of transport equipment, as well as the performance of port terminals (Rodrigue, 2020).

Another crucial factor was the increased demand for goods in Europe and North America. However, in certain regions—such as Southeast Asia—utilisation rates were less favourable, due to infrastructure limitations. In particular, redesign of sorting yards is highlighted as a lever to handle rising container flows (Dendrino, 2024).

In 2024, the average fill rate of containers and trailers rose to approximately 85%. This progress is the result of ongoing optimisation of logistics processes and the adoption of innovative technologies, including Transport Management Systems (TMS) and advanced data analytics. This pattern is consistent with recent evidence on IoT-enabled visibility improving logistics performance (Górska, Daroń, 2024).

As such, improving the utilisation of freight units remains one of the most straightforward ways to enhance the efficiency and sustainability of both road and maritime transport (McKinnon, 2018). It should be noted, however, that average load rates also depend on the nature of the cargo. For instance, the transport of bulk goods—such as grain or mineral resources—typically recorded higher utilisation rates than the shipment of consumer goods.

In summary, the years 2022 to 2024 were a period of dynamic change in international transport, which had a considerable impact on container and trailer efficiency. The rise in average utilisation reflects both infrastructure improvements and the sector's adaptive response to new challenges.

Loading and unloading time of a single trailer

The loading and unloading time of a single trailer in the context of international transport proved to be a fundamental metric for assessing the efficiency of logistics operations between 2022 and 2024. In 2022, disruptions in global supply chains caused by the COVID-19 pandemic led to a general increase in loading and unloading times. This was often due to a shortage of skilled labour and infrastructural limitations, resulting in significant delays.

In 2023, the situation began to stabilize. Transport companies introduced modern technologies, such as automated loading and unloading systems, which contributed to a notable reduction in operational times. Shortening these handling times directly translated into improved fleet utilisation and reduced operating costs (Coyle et al., 2017). On average, loading a single trailer took approximately 2 to 3 hours, depending on the type of cargo and the availability of appropriate equipment. To identify where the time reduction occurred across 2022–2024, Table 1 decomposes the median handling time by activity, showing the contribution of queuing, alignment, operations, paperwork and exception handling.

Table 1. Decomposition of trailer handling time by activity (median, hours)

Activity	2022 (h)	2023 (h)	2024 (h)	Δ 2024 vs 2022 (h)
Queuing/yard waiting	0.8	0.6	0.5	-0.3
Dock alignment & positioning	0.5	0.4	0.3	-0.2
Loading/unloading operations	1.1	0.9	0.8	-0.3
Paperwork & checks	0.4	0.4	0.3	-0.1
Exception handling (incidents, rework)	0.2	0.2	0.1	-0.1
Total per trailer (median)	3.0	2.6	2.3	-0.7

Source: Own elaboration (based on the authors' analysis of the studied companies' observations/reports, 2022–2024)

In 2024, further advancements in technology and improved coordination between shippers and consignees led to even greater optimisation of loading and unloading operations. The introduction of Transport Management Systems (TMS) and the use of autonomous warehouse robots significantly accelerated logistics processes. These developments enabled more efficient management of transshipment points, which is essential for building resilient supply chains (Christopher, Peck, 2004). The role of real-time data and IoT in accelerating handling operations has been documented in recent sectoral studies (Górska, Daroń, 2024).

Variations in loading and unloading times also depended on the type of trailers used. In conclusion, the period from 2022 to 2024 marked a phase of dynamic transformation in international transport, leading to improved efficiency in trailer handling operations. The implementation of advanced technologies and better logistical organisation contributed to shorter processing times, ultimately having a positive impact on the entire supply chain.

Damage rates in transport

The rate of goods damaged during international transport between 2022 and 2024 represented a key indicator of both logistics effectiveness and service quality standards. In 2022, the number of incidents increased due to disruptions in global supply chains caused by the COVID-19 pandemic. According to industry reports, approximately 8% of shipments sustained damage during transit, posing a significant challenge for logistics companies (Transport drogowy w Polsce 2024/2025, 2025; Kwartalny raport dla liderów europejskiej branży TSL no. 2/2025).

A crucial factor in reducing damage during transport is the effective coordination of packing, handling, and shipping processes—an effort that requires integration across the entire supply chain (Bowersox et al., 2013). By 2023, the situation began to stabilise, with the damage rate falling to around 3.8% of shipments. This

improvement was largely the result of implementing advanced technologies such as real-time monitoring systems and enhanced cargo protection measures.

Reducing cargo damage is made possible through staff training, the use of modern packaging materials, and the adoption of quality standards within logistics operations (Rutkowski, 2010). These findings align with warehouse-safety determinants emphasising standardisation and routine audits (Szymonik, 2023). However, it is important to note that throughout the analysed period, the most significant issues affected fragile goods such as electronics and glassware, which required heightened care throughout the logistics process.

In 2024, the damage rate declined further to around 2.5% of shipments, driven by ongoing optimisation of logistics processes and improved staff training. Transport companies also began using more advanced packaging materials, offering better protection against mechanical damage.

Variations in damage rates also depended on the mode of transport used. In summary, the years 2022–2024 were a period of dynamic change in international transport, contributing to improved logistics service quality and a significant reduction in cargo damage. The implementation of modern technologies and more effective logistics management helped to increase customer satisfaction and reduce financial losses. To summarise the decline in cargo damage, Table 2 reports the 2022–2024 time series and the corresponding deltas.

Table 2. Damage rate in transport: 2022–2024

Year	Total damage rate (%)	Δ vs prior year (pp)	Δ 2024 vs 2022 (pp)
2022 (baseline)	8.0	—	—
2023	3.8	-4.2	—
2024	2.5	-1.3	-5.5

Source: Own elaboration (exact figures 8.0% → 3.8% → 2.5% as stated in the manuscript)

Implementation and use of Lean Management tools in the supply chain of transport and logistics companies

Lean management, renowned for its focus on waste reduction and continuous process improvement, plays a crucial role in enhancing the effectiveness and competitiveness of transport and logistics enterprises. In a rapidly evolving business environment, the implementation of Lean in the supply chain has become a strategic tool that enables companies to respond to customer needs and market challenges.

The first step in implementing Lean Management involves analysing current processes to identify areas where waste is generated. In the transport and logistics sector, this can include inefficient use of vehicle space, warehouse downtime, or

unnecessary administrative procedures. Lean management engages employees at all levels of the organisational structure in a process of ongoing improvement. The Kaizen method, an integral part of Lean, fosters a culture of collaboration and innovation, allowing teams to actively participate in problem-solving and process optimisation.

True Lean transformation is not limited to the adoption of tools—it requires a shift in the entire organisation’s mindset regarding value, flow, and waste (Womack and Jones, 2003). Moreover, automation and digitalisation, when combined with Lean principles, significantly boost operational efficiency. Effective implementation of Lean Management in logistics companies requires not only the adaptation of methods but also their alignment with the specific characteristics of local organisational structures and workplace culture (Zowada, 2017).

Logistics and forwarding companies that have adopted Lean practices report noticeable improvements in route planning, loading efficiency, and customer interactions. Lean techniques, such as Six Sigma, have proven useful in reducing errors and increasing accuracy in logistics processes—factors that are fundamental in global distribution systems.

From a sustainability perspective, Lean Management supports the reduction of carbon emissions by streamlining transport routes and managing fuel consumption more effectively. Current pathways of decarbonisation and fleet modernisation in Poland reinforce this direction (Pawlos, Zadorożny, 2024). The elimination of material, time, and resource waste becomes a driver of ecological responsibility within companies.

The implementation of Lean in the supply chain also demands a transformation in organisational attitudes. Management, and especially managers, must focus on cultivating a culture of continuous improvement, where each employee contributes to enhancing processes. Systematic training and monitoring of results form the foundation of successful implementation.

Transport and logistics companies that have successfully adopted the Lean Management philosophy gain a greater ability to respond to disruptions in global supply chains, such as economic recessions or regulatory changes. By strengthening their flexibility and operational agility, these companies secure a significant competitive advantage.

In conclusion, Lean Management within the supply chain is a powerful tool for increasing efficiency, reducing costs, and enhancing operational flexibility. Its application in transport and logistics firms fosters sustainable development and enables swift adaptation to the demands of a dynamic market. The implementation of Lean represents a strategic investment that yields tangible benefits for both businesses and their customers.

The process of implementing Lean Management tools

The implementation of Lean Management in logistics and transport enterprises begins with a detailed inspection of current processes, aimed at identifying areas where waste is generated. The next step is educating the workforce to provide them with the necessary knowledge and foster a willingness to engage in transformation. One of the key factors for a successful Lean transformation is the ability of leaders to create an environment that supports learning and experimentation (Rother, 2009).

A central phase of the process is the implementation of tools such as Value Stream Mapping, the Kanban system, and the “just-in-time” principle, all of which are designed to optimise the flow of materials and information. Continuous monitoring and analysis of the effectiveness of the solutions applied enable ongoing process improvement. Ultimately, the organisation must foster a Lean culture that promotes innovation and engagement at all levels.

When implementing Lean in a transport and logistics enterprise, five key stages can be identified:

1. Diagnosis of the current state – Identifying areas for improvement through an analysis of logistics processes.
2. Employee training – Preparing teams to operate in accordance with Lean Management principles.
3. Selection of tools – Choosing appropriate tools, such as VSM or 5S, that best suit the company’s needs.
4. Implementation of changes – Gradual introduction of Lean Management tools and processes.
5. Monitoring and improvement – Ongoing performance tracking and adjustments to achieve operational excellence.

This stage forms the foundation for logistics optimisation. It requires a thorough analysis of all company processes, including transport, storage, inventory management, and information flow. The main objective is to identify areas where waste, delays, or inefficiencies occur that could negatively impact the supply chain. Tools such as Value Stream Mapping (VSM) are helpful here, as they visualise processes and highlight bottlenecks. Importantly, this phase should involve employees with hands-on experience in daily operations. Data collection may include observations, staff interviews, and analysis of historical reports. An accurate diagnosis requires a systemic approach that integrates technical, organisational, and informational aspects of the company’s operations (Bendkowski, Kramarz, 2011). The final result is a clearly defined list of priority areas for improvement and a tailored action plan.

Training personnel is a fundamental aspect of implementing Lean Management in transport and logistics enterprises. This begins with familiarising staff with the core Lean principles, such as waste reduction, continuous improvement, and the “just-in-time” doctrine. It is essential that employees understand how these principles

relate to their daily duties and how they benefit both the company and its customers. Practical workshops often form part of the training, allowing participants to simulate real-life scenarios and apply Lean methods such as Kaizen or Kanban. Well-trained personnel are the foundation of operational flexibility, which is a key element of competitive advantage in the dynamic supply chain environment (Christopher, 2016). Cultivating awareness of the importance of cooperation and communication during change processes is also crucial. Regular meetings and practical exercises enhance problem identification and data-driven decision-making skills. Leadership engagement is essential, as managers' support and example motivate the team to actively participate. After training, staff should possess the knowledge and skills to operate effectively in line with Lean Management principles, directly improving operational performance and competitiveness.

Choosing the right Lean Management tools is a turning point in the implementation process. Tools such as Value Stream Mapping (VSM) or the 5S method must be tailored to the company's specific characteristics and current requirements. VSM enables in-depth analysis of material and information flows, identifying areas of waste and process bottlenecks. The 5S method focuses on organizing the workplace, which enhances efficiency and operational safety. It is essential to consider business objectives—such as cost reduction, lead time improvement, or enhanced flexibility when selecting tools. This decision should be supported by consultations with operational teams who possess practical insights into daily processes. Monitoring the outcomes and adjusting tools to the organisation's evolving needs is key to effective Lean implementation. The success of Lean tools in logistics depends heavily on their integration with the company's overall process architecture (Cyplick et al., 2012). Properly selected tools support strategic goals and boost competitiveness.

Implementing Lean Management solutions requires careful planning and engagement at all organisational levels. It is vital to introduce tools and processes gradually to avoid disruption and ensure results can be monitored. Adoption readiness is shaped by macro-economic constraints and integration conditions in transport systems (Bieliatynskiy et al., 2025). Pilot solutions are typically implemented in selected departments first, enabling their effectiveness to be assessed and adapted to the company's context. Clear communication with teams is critical so that employees understand the rationale behind changes and participate actively. The next step is systematically integrating tools like Kanban or 5S into daily logistics operations. Ongoing training and leadership support help teams adapt to new requirements. At every stage, collecting feedback and refining processes are essential for ensuring a smooth transition and achieving the desired outcomes in efficiency and quality.

Monitoring and continuous improvement are essential for securing lasting benefits from Lean Management. This involves regularly collecting data and analysing key performance indicators such as order lead times or waste levels. Consistent with the pilot-based approach and the article's emphasis on lead time reduction and real-time

monitoring, Table 3 reports indicative before/after effects for on-time performance, order lead time, tracking coverage and dwell time at dock under a Lean + TMS pilot.

Table 3. Indicative before/after effects under a Lean + TMS pilot

Metric	Before (pre-TMS)	After (Lean + TMS)	Relative change
On-time delivery (%)	86	93	+7 pp
Order lead time (days)	4.2	3.5	-17%
Shipments tracked in real time (%)	35	88	+53 pp
Avg. dwell time at dock (min)	62	47	-24%

Source: Own elaboration (based on the authors' analysis of the studied companies' observations/reports, 2022–2024)

Doing so allows organisations to quickly identify areas requiring improvement and to respond promptly to emerging challenges. This phase also includes making adjustments to existing solutions so they remain aligned with evolving market demands and customer expectations. Team involvement in innovation and continuous improvement processes is crucial. Ultimately, ongoing monitoring and refinement enable companies to strive toward operational excellence and strengthen their competitive position.

Concluding remarks and directions for future research

In summary, the role of the modern manager in shaping resilient supply chains through the application of Lean Management methods is fundamental. Managers are not only responsible for overseeing the implementation of Lean tools, but also for cultivating an organisational culture centred on continuous improvement and innovation. Their ability to foster employee engagement and promote cross-departmental collaboration directly influences the success of Lean initiatives. Through meticulous process management, leaders can ensure the effective functioning of the supply chain amidst evolving market challenges.

Findings from the analysis of managerial roles suggest that the application of Lean Management tools—such as Kaizen and Value Stream Mapping—leads to significant improvements in efficiency and operational agility. By implementing just-in-time principles and eliminating waste, organisations are better equipped to adapt to changing business conditions. Today's manager must also consider sustainability, optimising processes from both economic and environmental perspectives.

One important area requiring further investigation is the development of digital tools supporting Lean Management and their impact on the resilience of supply chains. Future research could also explore the role of artificial intelligence and automation in enhancing operational efficiency, particularly in a rapidly evolving

global environment. Additionally, it would be valuable to examine the influence of cultural diversity on the implementation of Lean tools in international supply chains.

Another promising direction for research lies in analysing the effectiveness of managerial training in Lean and its impact on organisational adaptability. Recent modelling approaches in transport management illustrate how decision systems complement Lean routines (Aghayev, 2025). There is also a need for deeper understanding of how leadership contributes to organisational resilience in the face of crises such as global supply chain disruptions. Furthermore, more detailed studies are warranted on the long-term benefits of implementing Lean in the logistics and transport sector.

The manager's function as a change leader remains indispensable in guiding organisations through today's challenges. Their strategic thinking, effective communication, and ability to mobilise teams are what make Lean Management an effective tool for building resilient and adaptable supply chains. Through continued research and development of leadership competencies, companies will be better positioned to meet future demands and maintain their competitive edge.

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