Towards Service Quality in Logistics in a Multi-Crisis Environment: The Combination of Lean and Digitalisation

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Abstract. Organisations operating in an environment of uncertainty are looking at 15-18 months to run operations at the same level as in the pre-crisis period. Therefore, companies have to focus on updating existing quality approaches, developing new models, and finding best practices. This paper aims to investigate the activities of a logistics company operating in Lithuania, which is implementing the lean philosophy through improving quality using information technology, and to analyse its actions in improving quality during the crisis. In order to achieve the set goal, the non-conformance management data of the parcel delivery company from 2016 to 2022 was analysed. During the research, it was found that the company had faced several crises, the most prominent of which was the increased demand for logistics services during the COVID-19 pandemic. The results show that new, emerging quality management challenges are managed by applying knowledge of lean management practices within two years.
Key words: *lean, digitalisation, logistics.*

Introduction

Relevance of the article

Logistics companies worldwide strive for market share by attracting customers and differentiating themselves from other market players through continuously improving systems and processes. New technologies such as big data management, Global Positioning System (GPS), and artificial intelligence (AI) have fundamentally changed the understanding of efficiency and convenience in business organisations (Chung, 2021). Technologies including data analytics, remote monitoring systems, automation (Ambika Zutshi, 2023), and remote collaboration tools can help organisations respond more effectively to change, consequently improving quality, significantly enhancing performance management, increasing competitiveness, productivity, effectiveness, and fostering the development of new skills and digital capabilities (Mazzarol, 2015). Applying new technologies creates an opportunity to gain advantages over competitors and achieve higher quality in logistics services (Akkaya & Kaya, 2019).

The unique political, economic, technological, and environmental challenges of the last five years (Narcevičius, 2022) have provided an opportunity to test and improve existing information technologies and methodologies to achieve the highest possible level of service quality.

Problem investigation level

The interest in the quality of logistics services provided by companies has been noticeable in the scientific literature for a long time, but the emergence of COVID-19 in 2019 highlighted the importance and vulnerability of logistics services, leading to increased research. It has been observed that the topic of the synergy between lean and IT is not emphasised in scientific articles related to logistics services, and only a few studies have theoretically formulated or modelled leadership strategies while maintaining the quality level. To assess a company's resilience to unexpected situations, it is crucial to explore further the aspects influencing the level of quality and how the company's IT and lean practices impact its operations.

Scientific problem.

How can lean and IT be utilised to maintain the quality level of logistics services?

Object of the article. The evolution of logistics services quality in companies that employ information technologies and lean principles.

Aim of the article. To investigate the activities of a logistics company operating in Lithuania that is implementing the lean philosophy to enhance quality through the use of information technology and to analyse its actions in quality improvement.

https://doi.org/10.15388/Gronskis.2024.2

Objectives of the article:

1. To analyse the scientific background related to the combination of lean and digitalisation;
2. To collect the data related to the activities of logistics companies operating in Lithuania that implement the lean philosophy while using information technologies to enhance quality and manage discrepancies;
3. To analyse the logistic company's actions in handling discrepancies during periods of uncertainty.
4. To evaluate the actions that positively influenced the restoration of the quality level.

Methods of the article

The study is based on empirical data on non-conformities in logistics companies for the period 2016–2022. Using descriptive statistics methods, the non-conformities recorded in the quality management system were analysed, characterising the one-day delay in the delivery of parcels. A clustering method was also applied to the empirical data according to the qualitative groups of non-conformities to identify the causes of the unevenness of service quality.

1. Theoretical and analytical aspects of service quality in logistics in a multi-crisis environment

External and Internal Challenges in the Logistics Industry

The logistics industry operates in a dynamic environment, encountering many external and internal challenges that shape its operations and performance. Logistics faces significant external challenges, such as new technologies, emerging market players, evolving customer expectations, and introducing new business models (Zaviša, 2023). Additionally, internal challenges include system complexity, inconsistent external regulations, and issues like a lack of competence, employee shortages, high turnover, rising costs for maintaining personnel and other resources, and fragmented communication. These factors create a constantly evolving landscape, requiring logistics companies to adapt and innovate to remain competitive.

Scientific literature points out specific challenges for logistics service companies, including infrastructure bottlenecks, the absence of efficient technical systems, a lack of government support policies, and a shortage of suitable key performance indicators (KPIs) (Gupta, Singh, & Suri, 2018), as well as reliance on traditional operational methods (Sharma, Panda, Mahapatra, & Sahu, 2011).

Companies grapple with daily difficulties that impact the level of logistics service quality. However, purposeful and consistent identification, monitoring, and resolution of these challenges contribute to greater resilience and learning by doing within the company. Amidst the challenges faced daily, purposeful and consistent identification, monitoring, and resolution of these issues pave the way for greater resilience and learning within logistics companies, ultimately driving forward the ongoing digital transformation in logistics.

Digital Transformation in Logistics

Companies providing logistics services face two main challenges: (1) increasing complexity in warehousing and transportation operations due to a growing market assortment and (2) the need to maintain stable efficiency as profit margins tend to decrease due to rising consumer expectations (Loske & Klumppc, 2020). In the face of product diversity, companies seek to reduce operational costs through tools such as Artificial Intelligence, automation, and digital transformations (Bell & Griffis., 2010). The European Parliament also facilitates the digitisation process, which has mandated that as of August 2024, national institutions must adopt the information provided by carriers in a digital format applicable across all EU countries (GmbH n.d.). Digitisation and digitalisation have become crucial in today's era of sustainable practices, aiming to maintain data flows (Menon, et al., 2022). Furthermore, insights from specific authors suggest that digitalisation empowers companies to develop eco-friendly innovations by considering their internal capacities (Ninga, Jianga, & Luo, 2023). Changes induced by the pandemic accelerated the digitisation processes in logistics, but companies still grapple with insufficient transparency, lack of information, and fragmented supply chains (Hartel, 2022). Additionally, the exchange of information among transportation participants often occurs chaotically and inefficiently, using

various means such as phones, various communicators, paper documents, or email (Waldmann & Kolinska, 2022). Researchers also indicate that 'high investment costs,' 'lack of financial resources,' 'inadequate internet connectivity,' 'lack of IT infrastructure,' and 'unclear economic benefits of digital investments' are the five main obstacles to implementing digital technologies during the pandemic (Gupta, Yadav, Kusi-Sarpong, Khan, & Sharma, 2022). Fatorachian and Kazemi note that there is a significant need to apply technologies such as Global Positioning System (GPS), barcode scanning, radio frequency identification (RFID), cloud computing, Big Data, and augmented reality in the logistics sector. However, the human skill set is insufficient to cope with these technological challenges (Fatorachian & Kazemi, 2018).

Companies providing logistics services have many interrelated systems, such as Logistics Process Management, Order System Management, Fleet Management, Transport Monitoring Management, Warehouse Management (3PL), Information Management, Cargo Management, Document Management, etc. Therefore, companies need to use data integration, processing, and presentation systems for data visualisation, analysis, and decision-making, such as Tableau, PowerBI, SQL, Python, or other systems.

Embracing digital transformation in logistics sets the stage for integrating innovative solutions, laying a robust foundation for implementing lean tools for nonconformities tracking, thereby optimising processes and enhancing overall operational excellence.

Lean Tool for Nonconformities Tracking

In the realm of quality management and continuous improvement, the utilisation of lean tools for nonconformities tracking stands as a pivotal strategy, offering organisations a structured approach to identify, address, and resolve deviations from established standards, thereby fostering enhanced operational efficiency and heightened quality standards. Quality is highly subjective (Werbińska-Wojciechowska, 2011); nevertheless, companies must create, monitor, and manage their service quality through a system of indicators or another tool. Companies must record complaints, claims, and internal nonconformities to achieve the highest service quality. Businesses can choose from a wide range of tools and methods designed to capture, improve, and enhance quality. One such tool, which involves reducing costs, inventory, and cycle time (quick response), improving delivery performance/customer satisfaction, ensuring a smoother workflow, and achieving higher efficiency in logistics, is the lean methodology (Sim, 2016) non-conformity management tool – PDCA (Zhang, 2014), where the abbreviations stand for *Plan*, *Do*, *Check*, and *Act*. PDCA provides an overview of the entire service process during work and conditions to avoid errors and waste (Amin, Mahmood, Kamat, & Abdullah, 2018).

The PDCA conceptual system is used to support and coordinate daily routine management, standard problem-solving processes, and continuous improvement efforts, and also aids the service development process (Nienaber & Barnard, 2007)

The lean methodology suggests capturing nonconformities on appropriate forms, but the development of information technology allows non-conformity management to be carried out using the software.

Lean and Digitalization – Foes or Friends

Both lean and digitalisation aim to improve efficiency, optimise processes, and enhance overall organisational performance, but they often approach these goals from different perspectives (Lorenz, Buess, Macuvele, Friedli, & Netland, 2019). Lean principles, derived from manufacturing and management practices pioneered by Toyota (Teich & Faddoul, 2013), focus on eliminating waste, improving flow, and creating value for the customer. Lean emphasises continuous improvement, employee involvement, and a systematic approach to problem-solving. Traditional lean practices have been associated with physical processes and visual management systems (Liker & Morgan, 2006). On the other hand, digitalisation involves the integration of digital technologies to transform business processes and operations (Haddud, 2020), it may include the use of data analytics, artificial intelligence, automation, and other technologies to streamline workflows, enhance decision-making, and improve overall agility.

Some scientists argue that lean practices may conflict with rapid digitalisation efforts, as lean traditionally involves incremental changes and may resist the rapid, transformative nature of digital technologies. Others believe that combining lean principles with digitalisation can create a powerful synergy, allowing organisations to achieve the benefits of both approaches (Trabucco & Giovanni, 2021).

In summary, the logistics industry navigates a complex landscape of external and internal challenges, including emerging technologies, market shifts, and operational inefficiencies. Digital transformation is a significant driver of change, enabling logistics companies to improve efficiency and customer satisfaction through real-time tracking, predictive maintenance, and secure transactions. Meanwhile, lean tools are crucial in tracking and addressing nonconformities, leading to more streamlined processes and higher quality outcomes. As companies integrate lean principles with digitalisation, they face both opportunities and potential conflicts. Balancing these approaches requires strategic planning and adaptability to thrive in the evolving logistics environment.

2. Research Methodology and Data Analysis on Lean and Digitalization Integration for Service Quality in Logistics

Research method and data

The aim of the research is to explore how the integration of lean principles and digitalisation strategies can enhance service quality within the logistics industry, particularly amidst challenging multi-crisis scenarios. This research seeks to investigate the synergies between lean methodologies and digital technologies, examining their combined impact on operational efficiency, resilience, and service delivery in the face of dynamic and unpredictable crisis environments.

The objectives of the research:

1. To investigate the principles and methodologies of lean management and digitalisation strategies relevant to the logistics sector;
2. To explore the potential synergies between lean principles and digitalisation strategies in enhancing service quality and resilience in logistics operations during times of crisis;
3. To identify barriers and challenges to the integration of lean and digitalisation in logistics operations and propose strategies for overcoming these obstacles.

The research was conducted at a logistics company in Lithuania that provided post service. To achieve the set goal, a qualitative analysis of statistical data was performed, focusing on the dynamics of nonconformities in the company's operations, also interview with three TOP management representatives was conducted. The selected company, operating in Lithuania for over 20 years, holds a leading position in its segment, providing postal and logistics services. With a workforce of 650 employees and sales revenue of 64 million Euros in 2022, it is classified as a large company. The company serves individual clients (B2C) and legal entities (B2B). It is innovative, implementing both managerial practices (LEAN, ISO) and technological innovations in its operations. Since implementing digital Quality Management tools, the company has accumulated statistical data on its activities since 2016.

Data. The research utilises data on non-conformity management in parcel delivery from 2016 to 2022, provided in .xls format from the Quality Management system. Only data related to delays in parcel delivery for one day are analysed. All company employees have access to the system, but only those in the transport and warehouse, customer service, and quality departments can record nonconformities in the system. The system is integrated with Microsoft Office products, and notifications about task assignments are sent via email. Employees responsible for task completion have predefined indicators (response time, decision-making time, first-time resolution) monitored in real-time. It is noteworthy that nonconformities are recorded in the system 24/7.

Data analysis method. The data were analysed using descriptive statistical methods, data gathered and categorised, analysed from different angles. The list of variables created by categories was based on the main variables concepts reviewed in the literature that influence service quality but were tailored to the specifics of the analysed company.

Analysis strategy

The strategic component of this study involves examining the non-conformity management tools utilised by the company, evaluating their effectiveness in reducing nonconformities, identifying interrelations, and conducting the interpretation, summarisation, drawing of conclusions, and formulation of recommendations based on the research results.

The research data analysis and the discussion of the results

Non-conformity Dynamics.

The nonconformities registered in the company's internal system were analysed during the research. The number of nonconformities was as follows (see Fig.1): in 2016 – 1668 units; in 2017 – 2013 units; in 2018 – 2317 units; in 2019 – 2657 units; in 2020 – 2610 units; in 2021 – 1651 units; and in 2022 – 1136 units. It is noteworthy that the number of shipments recorded in the same system since 2018 is as follows: in 2018 – 9.5 million units; in 2019 – 9.9 million units; in 2020 – 13,6 million units; in 2021 – 16,1 million units; and in 2022 – 18,7 million units. The highest number of nonconformities occurred in 2019, and since 2021, the number of nonconformities has been decreasing.

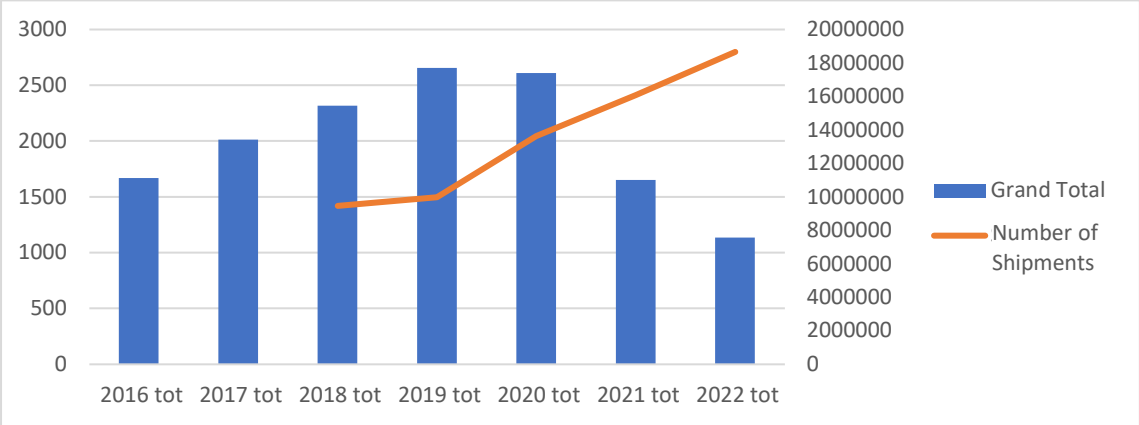

Fig.1. Dynamics of non-conformities (2016–2022)

These dynamics indicate that significant changes have occurred in the company, enabling the management of the growth in nonconformities (Fig.1). The transformation observed within the company's operations, as depicted in Figure 1, underscores the need for a strategic approach towards the development and implementation of the Company's Non-conformity Management Strategy.

Company's Non-conformity Management Strategy

In the examined logistics service-providing company, measures and methodologies for reducing nonconformities have been implemented since 2016. In 2016, the company obtained ISO 9001:2015 certification for Quality Management Systems and underwent a re-certification three years later, continuing its activities in accordance with the standard until 2022. In 2018, the company's management familiarised itself with the lean methodology, and tools such as an idea submission platform, a key performance indicator system, and the Plan-Do-Check-Act tool were introduced. Due to increasing shipments, the lean philosophy was not a prioritised strategy. However, efforts have been made to revitalise it since 2021 by implementing a gathering system, improving the non-conformity registration tool, simplifying audits, and forming project groups. Since 2019, the company has implemented digitisation and digitalisation tools, such as Tableau, Power BI, and tools that improve logistics processes, including GPS, RFID, NFC and others.

It is noteworthy that during the research period, the company experienced several shocks, some of which were officially recognised as crises—changes in C-level leadership, a shift in strategy, new partners, high turnover, and changes in the customer portfolio. One of the most prominent external events was the COVID-19 pandemic, which led to increased demand for logistics services.

While this is a positive phenomenon for the business, it poses a significant challenge to the company's management and sustainable growth.

Discussion of the results of the research

The analysis of non-conformity dynamics within the examined logistics service-providing company reveals interesting trends over the years. Despite fluctuations, there is a notable increase in non-conformities from 2016 to 2019, followed by a decline in 2020 and a further reduction in 2021 and 2022. These dynamics suggest that significant changes have occurred within the company, enabling effective management of nonconformities over time. The decrease in nonconformities since 2021 is particularly noteworthy, indicating successful efforts in addressing underlying issues and improving operational efficiency.

The implementation of the Company's Non-conformity Management Strategy has played a crucial role in addressing nonconformities and driving improvements within the organisation. Since 2016, the company has been committed to quality management systems, obtaining ISO 9001:2015 certification and continuously refining its processes to adhere to the standard. Additionally, the adoption of the lean methodology in 2018 has introduced various tools and methodologies aimed at streamlining operations and reducing nonconformities. Despite challenges posed by increasing shipments, efforts to revitalise the lean philosophy since 2021 have yielded positive results, with the implementation of new tools and project groups.

However, it is essential to note that the company faced several external shocks during the research period, including changes in leadership, strategy shifts, high turnover, and the COVID-19 pandemic. While these events posed challenges, they underscored the importance of adaptive strategies and resilience in navigating crises.

Overall, the combination of quality management systems, lean principles, and digitalisation tools has been instrumental in improving non-conformity management and enhancing service quality within the logistics company. The analysis results highlight the importance of a holistic approach to quality management, encompassing both strategic initiatives and technological advancements, to achieve sustainable growth and resilience in the face of evolving challenges.

Conclusion

1. Analysing the scientific background related to the combination of lean and digitalisation showed that leveraging both methodologies presents a promising avenue for enhancing operational efficiency, improving service quality, and fostering organisational resilience in dynamic business environments.
2. Collected data related to the activities of logistics companies operating in Lithuania that implement the lean philosophy while using information technologies to enhance quality and manage discrepancies revealed that companies experience notable improvements in process efficiency, resource utilisation, and customer satisfaction, indicating the effectiveness of integrating lean principles with digitalisation strategies.
3. Analysed logistic company's actions in handling discrepancies during periods of uncertainty disclosed that defying non-conformities (LEAN) creates prerequisites for targeted managerial interventions.
4. The increase in non-conformities recorded by the Lean system led to investment in the quality of the service system (including digitisation tools), but only after two years was a real improvement in quality (or reduction in non-conformities) observed.

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