European Research Studies Journal
Volume XXIX, Issue 2, 2026

pp. 630-645

Influence of Lean Management Tools on Parcel Sorting Process Improvement: A Case Study

Submitted 23/04/26, 1st revision 05/05/26, 2nd revision 20/05/26, accepted 29/06/26

Aleksandra Muszyńska[1], Paweł Just[2], Cezary Rapiejko[3]

Abstract:

Purpose: *The study aims to identify operational inefficiencies in a parcel sorting process and evaluate the impact of Lean Management tools on operational performance.*
Design/Methodology/Approach: *A six-month case study was conducted in a European parcel sorting centre using direct observation, process documentation analysis, KPI reviews, and employee interviews. Value Stream Mapping (VSM) and DILO analysis were applied to identify operational inefficiencies, while 5S, Total Productive Maintenance (TPM), and SQPA were implemented to improve workplace organisation, equipment reliability, and performance monitoring.*
Findings: *The results indicate that Lean implementation improved workplace organization, maintenance practices, performance transparency, and employee engagement.*
Practical Implications: *The study provides practical insights for logistics centres seeking process improvements through low-cost organisational solutions.*
Originality/Value: *The study demonstrates that the integrated use of Lean Management tools can increase process stability and operational efficiency without requiring significant technological investments.*

Keywords: *Lean Management, parcel sorting, VSM, 5S, TPM, SQPA.*

JEL codes: *L23, M11, R41.*

Paper type: *Case Study.*

[1]*Ms., Lodz University of Technology, Mechanical Department, Poland, ORCID: 0009-0005-2644-8748, e-mail: ola.muszynka@gmail.com;*
[2]*Lodz University of Technology, Polish Foundrymen Association, Poland, ORCID: 0000-0002-5305-8607*
[3]*Lodz University of Technology, Poland, ORCID: 0000-0001-8776-7340*

1. Introduction

The rapid expansion of e-commerce has significantly increased the importance of efficient parcel sorting processes. Sorting centres play a central role in ensuring timely delivery, yet rising shipment volumes introduce challenges related to process efficiency, equipment reliability, and operational coordination.

Lean Management has emerged as a widely applied approach to process optimization, focusing on waste elimination, flow improvement, and value creation. Although Lean has been extensively studied in manufacturing, its application in parcel sorting environments remains underexplored, particularly in relation to integrated maintenance and performance management.

The objective of this study is to identify inefficiencies in a parcel sorting process and evaluate the impact of Lean tools on operational performance using a real-world case study.

2. Literature Review

2.1 Lean Management in Logistics Operations

Lean Management has evolved from its origins in manufacturing into a widely adopted philosophy for improving efficiency in service and logistics systems. Its core objective is the systematic elimination of waste, enhancement of process flow, and delivery of value from the customer's perspective (James P. Womack, Lean Thinking: Banish Waste and Create Wealth in Your Corporation, 2003).

In logistics environments, the application of Lean principles has been driven by increasing system complexity and the rapid growth of e-commerce, which has intensified the need for responsive, high-throughput operations (Paulo Charrua-Santos, 2023). Parcel handling processes are particularly sensitive to inefficiencies due to their high variability, time constraints, and dependence on both human and automated activities.

Previous studies indicate that Lean implementation in logistics contributes to improved operational efficiency, reduced lead times, and enhanced process transparency. However, several authors emphasize that the effectiveness of Lean in service environments is often limited by contextual factors such as process variability, organizational culture, and the integration of human and technological systems (James C. Chen, 2024).

Moreover, unlike manufacturing systems where processes are more stable and repetitive logistics operations, especially parcel sorting, are characterized by fluctuating demand, heterogeneous shipments, and dynamic routing, which complicates the direct transfer of Lean tools without adaptation.

2.2 Application of Lean Tools in Process Analysis and Optimization

A wide range of Lean tools has been adapted for logistics process analysis. Among the most commonly used methods is Value Stream Mapping (VSM), which provides a holistic visualization of material and information flows across processes. VSM enables the identification of bottlenecks, waiting times, and non-value-added activities, supporting the redesign of processes toward a more efficient future state (Nuri Ozgur Dogan, Value Stream Mapping: A Method That Makes the Waste in the Process Visible, 2019).

Empirical studies confirm that VSM can significantly improve process transparency and resource utilization in logistics and service operations. However, its effectiveness may be constrained in highly dynamic environments, where process variability limits the stability of mapped states (Lugert, 2018).

Complementary tools such as spaghetti diagrams and flowcharts are frequently used to analyse movement patterns and identify inefficiencies related to layout design and transportation flows. These tools are particularly valuable in logistics centres, where excessive movement and poor layout design often lead to increased handling time and operational costs (Kovács, 2019).

Despite their usefulness, existing studies suggest that Lean tools are often applied in isolation rather than as part of an integrated improvement framework. This fragmented implementation reduces their overall impact and limits their ability to address systemic inefficiencies.

2.3 Maintenance Management in Lean Systems

Equipment reliability is a critical factor influencing process performance in automated and semi-automated environments such as parcel sorting centres. Within Lean systems, maintenance is not treated as a separate function but as an integral component of continuous improvement.

Total Productive Maintenance (TPM) is one of the most widely adopted approaches, focusing on maximizing equipment effectiveness through preventive and autonomous maintenance activities (Amandeep and Singh, 2013). TPM promotes operator involvement in maintenance tasks, early detection of faults, and reduction of unplanned downtime.

Previous research demonstrates that TPM implementation contributes to increased equipment availability and reduced breakdown frequency. However, several studies highlight challenges in sustaining TPM practices, particularly in service environments where maintenance responsibilities may be less clearly defined and operational priorities dominate
(Hubert Biedermann, 2019).

Additionally, the transition from reactive to preventive maintenance requires not only technical tools but also organizational changes, including standardization, training, and performance monitoring systems. Without these supporting mechanisms, maintenance improvements tend to be short-lived.

2.4 Performance Management, Visual Systems and Continuous Improvement

Continuous improvement in Lean systems relies heavily on performance measurement and transparent communication. Organizations increasingly adopt Key Performance Indicators (KPIs) to monitor operational effectiveness, including metrics such as throughput, lead time, and equipment utilization (Martin Dörnhöfer, Logistics Performance Measurement System for the Automotive Industry, 2016).

Visual management tools, such as SQPA boards, play a crucial role in supporting real-time performance monitoring and facilitating communication between employees and management. By integrating safety, quality, performance, and operational actions into a single framework, SQPA systems enhance operational awareness and enable faster decision-making (Algan Tezel, 2016).

Although performance management systems are widely recognized as essential for sustaining Lean improvements, existing literature indicates that their implementation is often inconsistent. In many logistics environments, performance data are collected but not effectively used for decision-making or continuous improvement activities. This gap between data availability and actionable insight remains a significant challenge.

Furthermore, employee engagement is frequently identified as a critical success factor. Studies show that Lean initiatives are more effective when employees are actively involved in problem identification and improvement activities. However, in practice, many organizations struggle to develop mechanisms that systematically support such involvement.

2.5 Research Gap and Positioning of the Study

Despite the growing body of research on Lean Management in logistics, several important gaps can be identified.

First, existing studies predominantly focus on warehouse operations or manufacturing environments, with limited attention given specifically to **parcel sorting centres**, which combine automated systems with labour-intensive activities. This hybrid nature introduces additional complexity that is not fully addressed in current literature.

Second, while individual Lean tools such as VSM, 5S, or TPM have been extensively analysed, there is a lack of studies examining their integrated application

within a single operational environment. In particular, the combined impact of process optimisation, maintenance management, and performance monitoring remains insufficiently explored.

Third, previous research highlights challenges related to the sustainability of Lean implementations, especially in dynamic logistics systems. However, limited studies provide practical insights into how visual management systems and maintenance practices can be aligned to support long-term process stability.

Finally, there is a noticeable lack of empirical studies that link process-level analysis (e.g. VSM, DILO) with organizational improvement mechanisms such as TPM and SQPA in real logistics operations.

To address these gaps, this study presents a case study of a parcel sorting centre, focusing on the integrated application of Lean Management tools to improve process efficiency, maintenance practices, and operational performance. By combining process analysis with organizational improvement initiatives, the research contributes to a more comprehensive understanding of Lean implementation in complex logistics environments.

3. Research Methodology

The study was conducted using a qualitative case study approach, which is widely applied in logistics and operations management research to enable in-depth analysis of real processes within their operational context. The research was carried out in a large European parcel sorting centre operating in the postal and logistics sector.

The primary objective of the study was to identify operational inefficiencies within the parcel sorting process and evaluate the application of Lean Management tools in improving operational performance. The analysis focused on material flow, process structure, workplace organisation, maintenance practices, and operational communication.

Data collection was conducted over a six-month period and included multiple complementary methods to ensure methodological triangulation. These methods involved direct process observations, analysis of process documentation, KPI reports, and maintenance records, as well as structured and semi-structured discussions with employees and supervisors. Particular attention was given to identifying process disruptions, transportation inefficiencies, waiting times, and non-value-added activities.

The study covered both automated and manual operations within the sorting process. Several Lean Management tools were applied to support the analysis, including:

- Value Stream Mapping (VSM),

- DILO (Day in the Life Of) analysis,
- process flow analysis,
- visual observations and workplace audits.

The research procedure was structured in three main stages:

- Analysis of the current state of the parcel sorting process,
- Identification of inefficiencies and improvement opportunities,
- Development and implementation of improvement actions based on Lean principles.

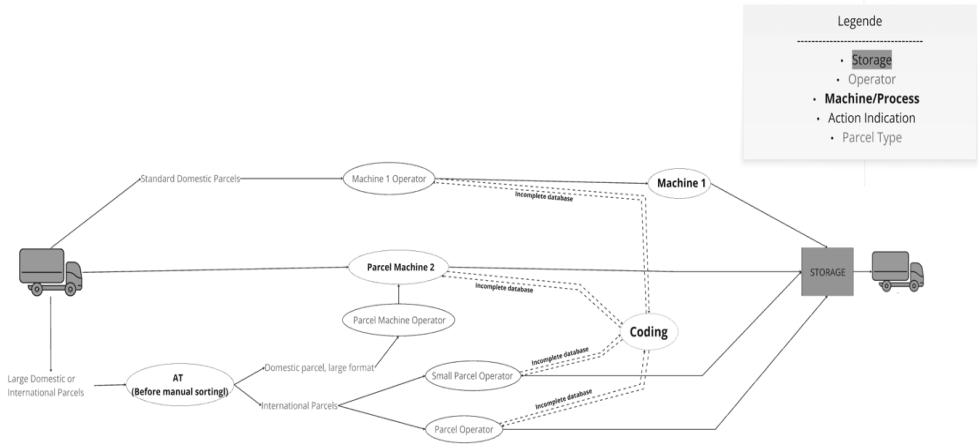
The use of multiple analytical methods enabled a comprehensive understanding of the process and supported the development of practical improvement solutions.

4. Research Results and Discussion

4.1 Process Characteristics

The analysed parcel sorting process integrates automated sorting technologies with manual handling operations. Parcels entering the system are classified based on their size and processing requirements and are subsequently directed to one of two sorting systems. The overall process flow is presented in Figure 1.

Figure 1. *Parcel sorting workflow*



Source: *Own study.*

A significant proportion of shipments originates from integrated customers, allowing full automation of the sorting process. In contrast, parcels from non-integrated customers require additional manual operations, including scanning, label generation, and verification. In cases where shipment data cannot be automatically

identified, parcels are redirected to a coding department, where additional manual verification is performed.

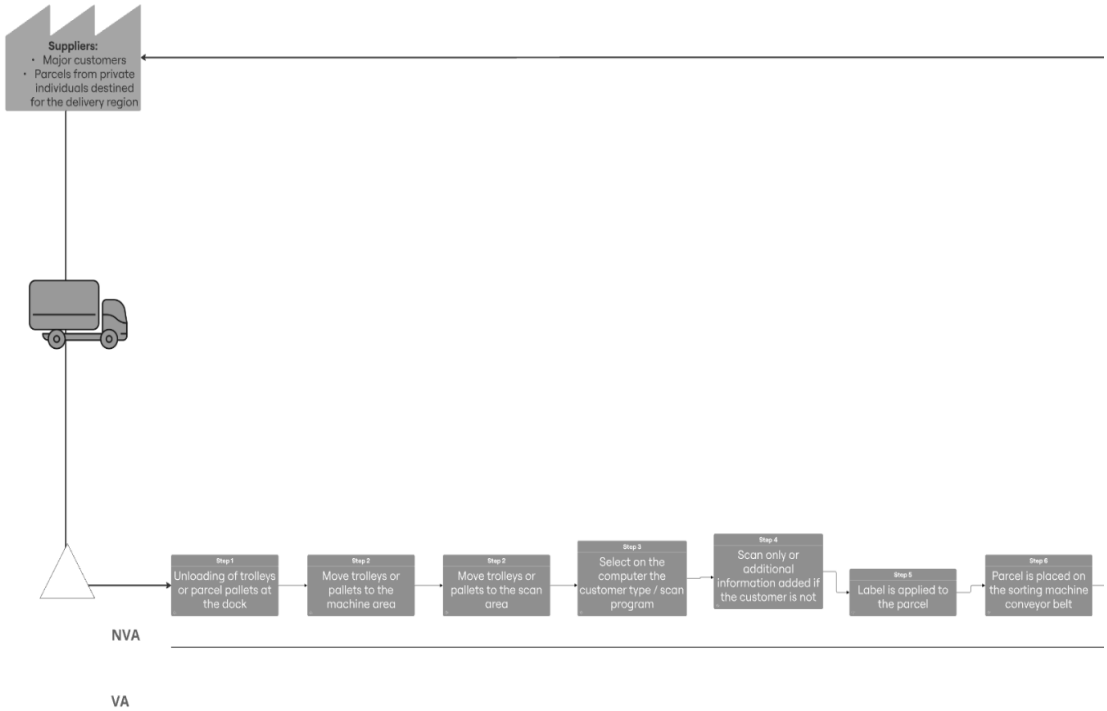
As illustrated in Figure 1, parcels are processed through different operational paths depending on customer integration and data availability. Whilst most parcels can be sorted automatically, some require additional manual intervention before being transferred to the appropriate sorting machine.

The process also involves extensive internal transportation using carts and trolleys, connecting unloading areas, sorting machines, and dispatch zones. As a result, process efficiency is influenced not only by machine performance but also by layout design, transportation flows, and operator involvement.

4.2 VSM Analysis of the Parcel Sorting Process

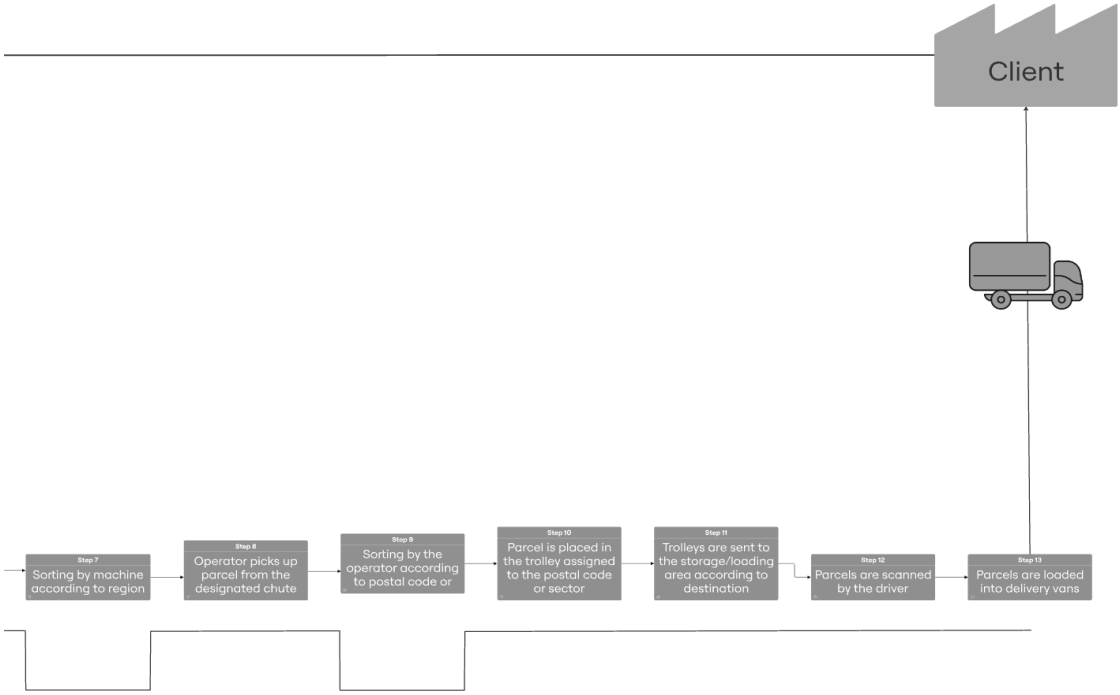
Value Stream Mapping (VSM) was used to analyse the current state of the parcel sorting process and identify value-adding and non-value-adding activities. The map provided a visual overview of material and information flows from parcel receipt to dispatch preparation. The current-state value stream map is presented in Figure 2 and 3.

Figure 2. *Value Stream Map of the parcel sorting process (start)*



Source: *Own study.*

Figure 1. *Value Stream Map of the parcel sorting process (finish)*



Source: *Own study.*

The analysis showed that the process includes both automated sorting operations (value-adding) and several non-value-adding activities, mainly related to transportation, manual scanning, and label generation. Additional manual intervention was required in cases of missing or incorrect shipment data, which increased processing time.

A significant amount of internal transportation between unloading, sorting, and dispatch areas was also identified, contributing to increased handling time and reduced efficiency.
The VSM further revealed limited visibility of operational performance and a lack of structured visual management and preventive maintenance support.

4.3 Identification of Key Inefficiencies

The analysis revealed several critical inefficiencies affecting operational performance.

First, a lack of structured performance monitoring limited the ability to track operational results and respond to deviations in real time. Although data were available, they were not systematically visualised or used for daily decision-making.

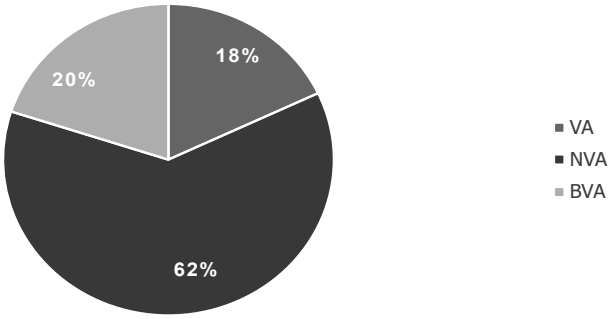
Second, maintenance practices were predominantly reactive. The absence of standardised preventive maintenance procedures and inspection routines increased the risk of equipment failures and operational disruptions.

Third, communication between operational teams was not supported by structured visual management systems. This reduced transparency and limited the effectiveness of information flow regarding performance, safety, and process disruptions.

Finally, the analysis identified a high proportion of non-value-added activities, particularly related to transportation, coordination, and organisational tasks.

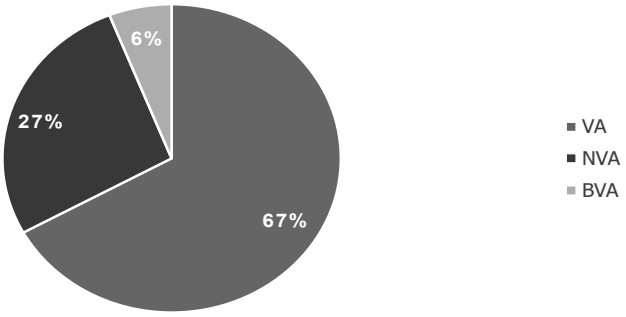
The DILO analysis provided quantitative insight into these inefficiencies. A breakdown of Value-Added (VA), Non-Value-Added (NVA), and Business-Value-Added (BVA) activities for both machines is presented in Figure 4 and Figure 5.

Figure 2. *Chart illustrating the distribution of VA, NVA, and BVA activities – Machine 1*



Source: *Own study.*

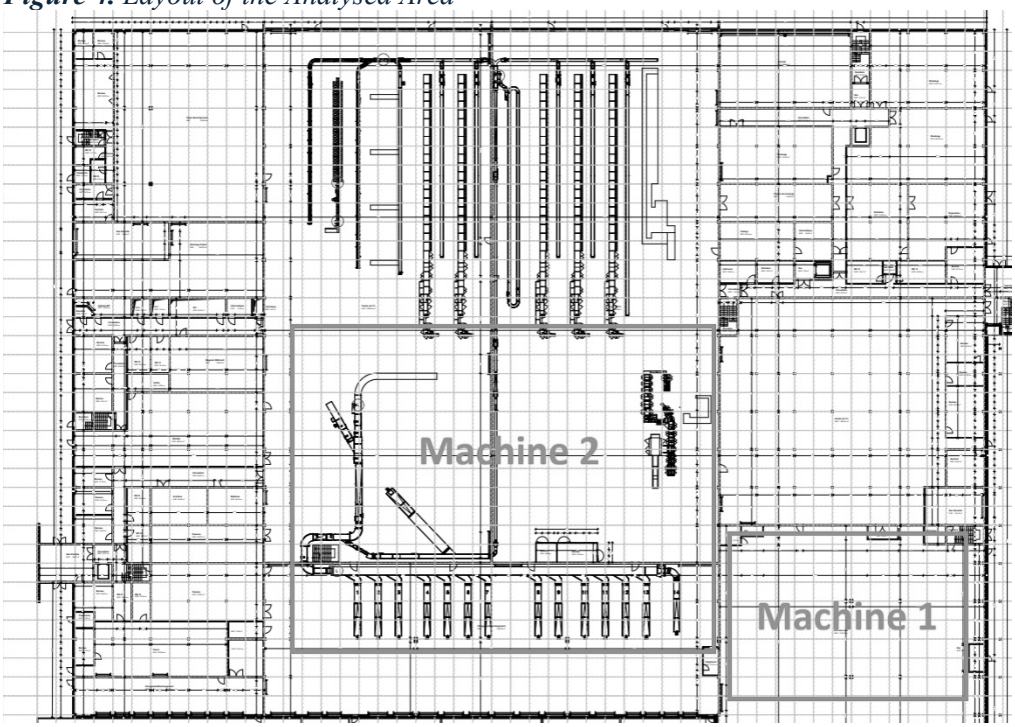
Figure 3. *Chart illustrating the distribution of VA, NVA, and BVA activities – Machine 2*



Source: *Own study.*

For Machine 1, up to 62% of activities were classified as non-value-added, while only 18% contributed directly to value creation. In contrast, Machine 2 exhibited a significantly more efficient structure, with approximately 67% of activities classified as value-added. The layout of both machines, including their positions and configuration within the production area, is presented in Figure 6.

Figure 4. *Layout of the Analysed Area*



Source: *Own study.*

This discrepancy highlights the impact of process organisation and work structure on operational efficiency.

5. Improvement Implementation

Based on the identified inefficiencies, a set of Lean Management solutions was implemented, focusing on workplace organisation, maintenance management, and performance monitoring.

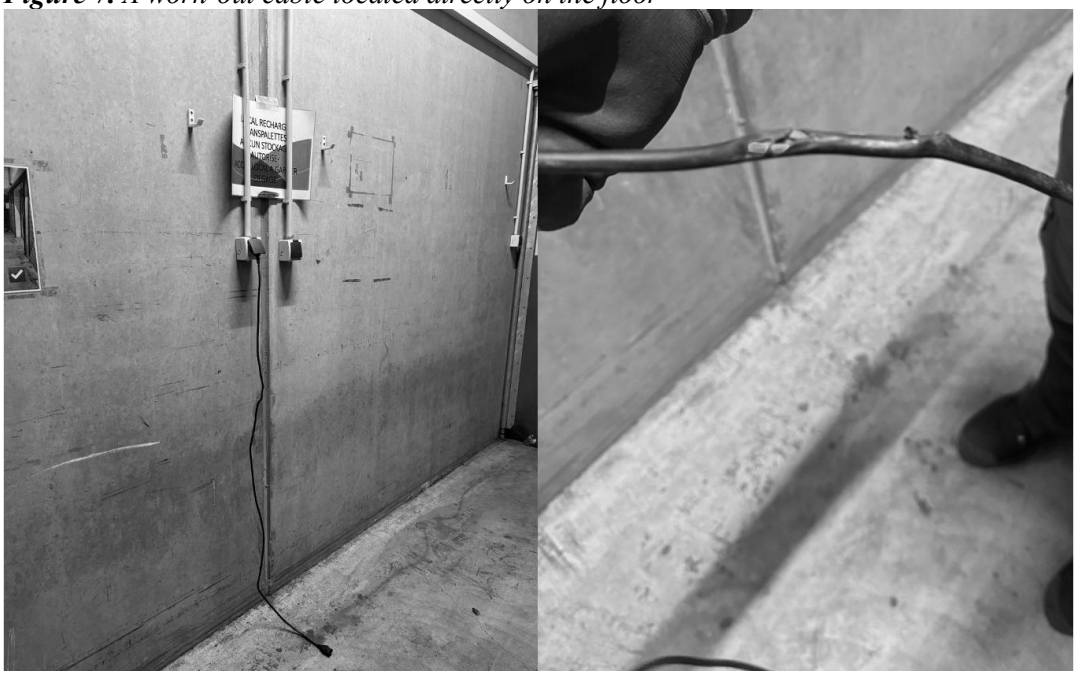
5.1 5S – Workplace Organization

The 5S methodology was implemented to improve workplace organisation, safety, and operational efficiency. The initiative involved the removal of unnecessary items, optimisation of workstation layout, and introduction of visual management elements.

The implementation included all five stages of 5S: sorting, set in order, cleaning, standardisation, and discipline. Special attention was given to improving visual markings and defining storage areas for transport equipment, which reduced unnecessary movement and improved workplace clarity.

Additionally, the cleaning process enabled the identification of safety risks, including damaged equipment and infrastructure issues. One example of such finding is presented in Figure 7, showing a worn-out cable located directly on the floor in an area exposed to water and regular cleaning activities. This represented a potential risk of electric shock and equipment damage. The cable was immediately replaced.

Figure 7. *A worn-out cable located directly on the floor*



Source: *Own study.*

The systematic implementation of 5S contributed to improved workplace conditions, reduced time losses, and enhanced process transparency.

5.2 TPM – Preventive Maintenance

To improve equipment reliability, Total Productive Maintenance (TPM) practices were introduced through standardised inspection checklists applied to sorting machines and transport equipment (Figure 8).

Figure 5. *Example of a TPM checklist*

			Before verification		After compliance	
N°	Type	Tasks	OK	NOTOK	OK	NOTOK
1	Machine	Conveyor belt control – check the sensors				
2	Machine	Check the machine's computer to identify broken screws using the plate number				
3	Machine	Control of pusher arms – check if they are adjusted, tightened, and if the linear guide works				
4	Machine	Inspection of X90 wheels – check functionality and ensure no damaged coils block the rails				
5	Machine	Check distance (2-4 mm) between platform and wheel set				
6	Machine	Check the 4 pusher sensors (in/out)				
7	Machine	Check the 2 tray presence sensors				
8	Machine	Check the 5 horizontal sensors – verify adjustment and cleanliness				
9	Machine	Operation and adjustment of switches				
10	Machine	Push-up plate control – ensure it's not too low; adjust or replace if necessary				
11	Machine	Configuration of the repaired platforms				
12	Scanner	Scanner alignment check				
13	Scanner	Mirror check – cleaning and ensuring it's dirt-free				
14	Scanner	Tray inspection – check for absence of labels or glue residue				
15	Scanner	Parcel test – check if the scanner correctly detects parcel sizes				
16	Chutes	Chute motor control – check belt tension and adjust if necessary				

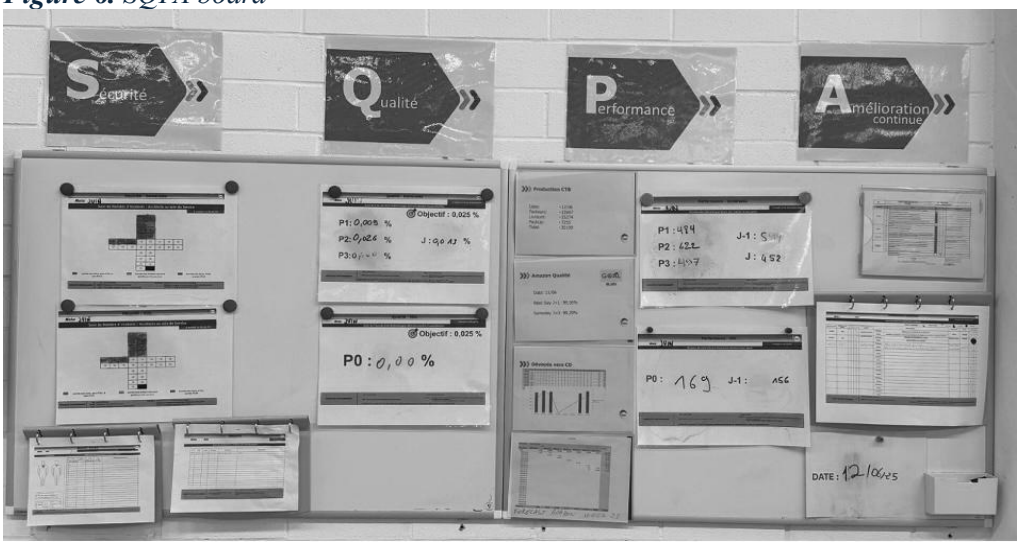
Name	Firstname	Signature	Date

The TPM system focused on preventive maintenance and operator involvement. Employees were responsible for conducting routine inspections, which enabled early detection of potential failures and reduced the risk of unplanned downtime.
The implementation of TPM checklists improved standardisation and consistency of maintenance activities. Additionally, the introduction of a Computerised Maintenance Management System (CMMS) supported the monitoring and documentation of maintenance tasks, enhancing communication between operational and technical teams.

5.3 SQPA – Performance Management

To address the lack of performance monitoring and communication transparency, SQPA (Safety, Quality, Performance, Continuous Improvement boards were introduced as a visual management tool (Figure 9).

Figure 6. *SQPA board*



Source: *Own study.*

The SQPA system provided real-time visibility of key performance indicators and operational issues. Daily SQPA meetings were implemented to review performance, discuss problems, and assign corrective actions.

This approach improved communication, increased employee engagement, and enabled faster response to operational disruptions. Additionally, the integration of audits within the SQPA framework supported continuous monitoring and improvement of operational standards.

6. Conclusions and Recommendations

The implementation of Lean Management tools resulted in significant improvements across several operational dimensions (Table 1).

Table 1. *Comparison of operational performance before and after Lean Management implementation*

Area	Before Improvement	After Improvement
Workplace organisation	Lack of standardised workplace organisation and visual management	5S standards implemented, improved organisation and visual controls
Workplace cleanliness	Cleaning activities performed inconsistently	Standardised cleaning procedures and regular audits introduced
Equipment inspections	Inspections performed inconsistently	Standardised TPM checklists introduced
Equipment maintenance	Predominantly reactive approach	Increased focus on preventive maintenance
Maintenance reporting	Limited documentation of equipment issues	Structured reporting supported by TPM procedures and CMMS
Performance monitoring	Limited visibility of operational indicators	SQPA boards implemented for daily KPI monitoring
Communication	Information shared through informal communication channels	Structured daily SQPA meetings introduced
Continuous improvement activities	No formal audit system	Quality and operational audits introduced
Problem identification	Issues often identified after affecting performance	Faster identification and escalation of operational issues
Employee involvement	Limited participation in improvement activities	Increased engagement through visual management, TPM, and SQPA practices

Source: *Own elaboration.*

The introduction of 5S led to improved workplace organisation, enhanced safety, and better accessibility of tools and equipment. Standardisation reduced variability and supported more efficient task execution.

TPM implementation improved equipment reliability and enabled a transition from reactive to preventive maintenance. The involvement of operators in maintenance activities increased awareness and contributed to faster identification of technical issues.

The SQPA system enhanced performance visibility and communication. Daily meetings and visual management tools provided a structured approach to monitoring operational performance and resolving issues.

The combined effect of these improvements was the development of a more structured, transparent, and stable operational process. Importantly, the improvements were achieved without significant investments in automation or advanced technologies, demonstrating the effectiveness of organisational solutions in logistics environments.

7. Conclusions

The study demonstrates that Lean Management tools can be effectively applied to improve operational performance in parcel sorting processes. The integration of 5S, TPM, and SQPA enabled improvements in workplace organisation, maintenance management, and performance monitoring.

The results indicate that combining process analysis with organisational improvement mechanisms contributes to increased process stability, operational efficiency, and employee engagement. The study also highlights the importance of integrating multiple Lean tools, rather than implementing them in isolation.

From a practical perspective, the proposed solutions provide a scalable and cost-effective approach to process improvement in logistics operations. The findings may be particularly relevant for organisations seeking to improve performance without significant capital investment.

Future research should focus on quantitative evaluation of performance improvements and long-term sustainability of implemented solutions.

References:

Algan Tezel, L.K. 2016. Visual Management in Production Management: A Literature Synthesis. Journal of Manufacturing Technology Management.

Amandeep Singh, H.S. 2013. Total Productive Maintenance (TPM) Implementation in a Machine Shop: A Case Study. Procedia Engineering.

Ambra Galeazzo, A.F. 2021. The Role of Employees' Participation and Managers' Authority on Continuous Improvement and Performance. International Journal of Operations & Production Management.
Bicheno, J. 2004. Dans The New Lean Toolbox: Towards Fast, Flexible Flow. London: PICSIE Books.
Boston Consulting Group (BCG). 2023. Winning Formulas for E-Commerce Growth. Boston, Massachusetts, USA: Boston Consulting Group.
Carvalho, D. 2020. Continuous Improvement. Dans Concepts, Applications and Emerging Opportunities in Industrial Engineering. London, United Kingdom: IntechOpen.
Courier services are evolving rapidly, c.a. 2024. Multitrip Vehicle Routing with Delivery Options: A Data-Driven Application to the Parcel Industry. OR Spectrum.
De Koster, T.L.D. 2007. Design and Control of Warehouse Order Picking: A Literature Review. European Journal of Operational Research.
DHL Supply Chain. 2024. Warehouse of the Future. Bonn, Niemcy: DHL.
Dörnhöfer, F.S. 2016. Logistics Performance Measurement System for the Automotive Industry. Logistics Research.
Filip Hardt, M.K. 2021. Innovative Approach to Preventive Maintenance of Production Equipment Based on a Modified TPM Methodology for Industry 4.0. Applied Sciences.
Grajewski, P. 2012. Procesowe zarządzanie organizacją. Wyd. PWE. Warszawa.
Grazia Antonacci, L.L. 2021. Process mapping in healthcare: a systematic review. BMC Health Services Research.
Hadid, S.M. 2016. Lean thinking for a maintenance process. Production & Manufacturing Research.
Hicham El Bahraoui, Y.E. 2022. Optimization of the Sustainable Distribution Supply Chain Using the Lean Value Stream Mapping 4.0 Tool: A Case Study of the Automotive Wiring Industry. Processes.
Hubert Biedermann, A.K. 2019. Lean Smart Maintenance—Value Adding, Flexible, and Intelligent Asset Management. BHM Berg- und Hüttenmännische Monatshefte.
James, C., Chen, D.A.L. 2024. Current Research and Future Challenges in Parcel Hub towards Logistics 4.0: A Systematic Literature Review from a Decision-Making Perspective. International Journal of Production Research.
James, P., Womack, D.T. 2008. Lean Thinking – szczupłe myślenie. Wrocław: ProdPress.
James, P., Womack, D.T. 2003. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Boston, Massachusetts, USA: Lean Enterprise Institute.
Jennifer Kononowech, Z.L.L. 2020. Visual Process Maps to Support Implementation Efforts: A Case Example. Implementation Science Communications.
John, P. 2022. Overview of Value Stream Mapping. Journal of Industrial Engineering and Management.
Kanban Tool Team. 2021. Co to jest Diagram Przepływu (Flowchart)? Récupéré sur Kanban Tool. https://kanbantool.com/pl/przewodnik-kanban/flowchart-diagram-przeplywu.
Kovács, G. 2019. Layout Design for Efficiency Improvement and Cost Reduction. Bulletin of the Polish Academy of Sciences: Technical Sciences
Kristina Čižiūnienė, A.Š. 2025. Analysis of Parcel Delivery Issues at 'State Parcel Company': An Examination of Customer Complaints and Interrelationships. Logistics.
Lilianna Wojtynek, E.K.G. 2018. Implementation of Lean 5S Methodology in Logistic Enterprise. Research in Logistics & Production.

Lugert, A.B. 2018. Empirical Assessment of the Future Adequacy of Value Stream Mapping in Manufacturing Industries. Journal of Manufacturing Technology Management.

Martin Dörnhöfer, F.S. 2016. Logistics Performance Measurement System for the Automotive Industry. Logistics Research.

McCarthy, P.W. 2021. Problemy w obszarach produkcyjnych. Rzeszów: Wydawnictw Politechniki Rzeszowskiej dr hab. inż. Lesław Gniewek, prof. PRz.

Ngoc-Ai-Thy Nguyen, C.N.W.T. 2025. Advanced Process Optimization in Logistics and Supply Chain Management. Processes.

Nuri Ozgur Dogan, B.S. 2019. Lean Manufacturing and Six Sigma – Behind the Mask. IntechOpen.

Nuri Ozgur Dogan, B.S. 2019. Value Stream Mapping: A Method That Makes the Waste in the Process Visible. London, United Kingdom: IntechOpen.

O'Donnell, J. 2024. What are Parcel Sorting Centers? Récupéré sur BlueCrest. https://www.bluecrestinc.com/blog/what-are-parcel-sorting-centers.

Ohno, T. 1988. Toyota Production System: Beyond Large-Scale Production. Cambridge Productivity Press.

Oskars Vismanis, J.A. 2023. Robotic System for Post Office Package Handling. Applied Sciences.

Paulo Charrua-Santos, L.A. 2023. Lean Principles in Logistics Operations: A Systematic Literature Review. Logistics.

Pierre-William Albert, M.R. 2023. Trends and New Practical Applications for Warehouse Allocation and Layout Design: A Literature Review. SN Applied Sciences.

Stadnicka, D. 2021. Problemy w obszarach produkcyjnych Część 2. Pracownik i technologie przyszłości. Rzeszów: Oficyna Wydawnicza Politechniki Rzeszowskiej.

TRANSlogis. 2024. Czym są wąskie gardła w logistyce i jak można je wyeliminować? Récupéré sur TRANSlogis. https://www.translogis.pl/pl/nws/czym-sa-waskie-gardla-w-logistyce-i-jak-mozna-je-wyeliminowac.

Vorne Industries, Inc. 2020. TPM (Total Productive Maintenance). Récupéré sur TPM (Total Productive Maintenance). https://www.leanproduction.com/tpm/.

Wang, C.N., Vo, T.T., Chung, Y.C., Amer, Y., Doan, L.T. 2024. Improvement of Manufacturing Process Based on Value Stream Mapping: A Case Study. Engineering Management Journal.

World Economic Forum. 2020. The Future of the Last-Mile Ecosystem. Cologny/Geneva, Switzerland: World Economic Forum.