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Integrated Lean Management - Resilience Engineering Approach For Supply Chain Performance Improvement

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ABSTRACT

In the era of globalization and increasingly fierce competition, companies face complex challenges in managing supply chains that are both efficient and resilient to unexpected disruptions. Lean management approaches that focus on waste elimination can create vulnerabilities, while resilience engineering offers system robustness but may potentially reduce efficiency. This research aims to analyze the implementation of integrated lean management – resilience engineering approaches to improve supply chain performance holistically. The research employed a mixed-methods approach with a before–after comparison study design conducted over 12 months in a manufacturing company. The research sample involved 16 respondents from various organizational hierarchy levels, consisting of directors, managers, supervisors, and operational staff from five supply chain divisions (sales, procurement, production, warehouse, and logistics). The integrated implementation showed significant improvements across all divisions. The sales division experienced 39.7% sales growth, the production division achieved a 117% productivity improvement with a 54% lead time reduction, the warehouse division increased capacity by up to 1,400%, while the logistics division successfully minimized customer complaints and optimized operational costs. Overall, organizational performance improved from the "Needs Improvement" category (195.12 points/39%) to the "Adequate" category (343.56 points/69%). The integration of lean management and resilience engineering proved effective in improving supply chain performance through simultaneous optimization of operational efficiency and system resilience strengthening, creating a supply chain that is not only lean but also resilient.

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INTRODUCTION

In an increasingly complex global business landscape, organizations face challenges in the form of unforeseen disruptions, ongoing technological changes, and new competitive dynamics that demand adaptive and responsive strategies (Garcia-Buendia et al., 2025). The COVID-19 pandemic has further exposed global supply chain vulnerabilities, causing supply disruptions and demand spikes (Chen et al., 2024). The implementation of Industry 4.0 technologies has become key to enhancing supply chain resilience through the integration of digital technologies that strengthen organizational anticipation and response capabilities (Patel et al., 2022). Climate change-induced disruptions, geopolitical tensions, and structural dynamics underscore the urgency of adaptive management strategies, including the incorporation of complementary management systems (Williams et al., 2025; Klein et al., 2022).

Lean Management is recognized as an effective approach for improving operational efficiency through waste elimination, value stream mapping, and continuous improvement (Iyer et al., 2020; Johnson et al., 2024; Martinez et al., 2021; Bernhard et al., 2023). However, an exclusive focus on efficiency can create vulnerabilities to disruptions (Thompson, 2025). Resilience Engineering offers a complementary framework by emphasizing the ability of systems to anticipate, adapt to, and recover quickly from disturbances (Szatmari et al., 2024). Empirical studies confirm that supply chain resilience depends not on risk elimination but on risk navigation

through cross-sector collaboration, digital technology, and operational flexibility (OECD, 2025; Kumar et al., 2024; Lee et al., 2024).

The synergy between Lean Management and Resilience Engineering is viewed to optimize supply chain performance by balancing efficiency and resilience (Xue & Li, 2023). Lean practices have been shown to strengthen resilience through data optimization and resource allocation (Anderson et al., 2025), while the integration of the two provides a comprehensive approach to managing uncertain business dynamics (Pawar et al., 2022; Rodriguez et al., 2021). Previous research across various contexts, including the clinical sector and healthcare organizations, has demonstrated the effectiveness of this Integrated Lean Management – Resilience Engineering Approach in improving operational performance while maintaining sustainability (Nakamura et al., 2022; Zhang et al., 2025). Thus, this study emphasizes the importance of a supply chain management model capable of combining lean efficiency with resilience to address modern industrial challenges.

METHOD

This study employed mixed methods with a before–after comparison design to evaluate the impact of Lean Management and Resilience Engineering integration on supply chain performance. The research was conducted in a manufacturing company with a complete supply chain structure (sales, procurement, production, warehouse, and logistics) over a period of 12 months through three stages: baseline assessment (2 months), strategy implementation (6 months), and evaluation (4 months). The sample was determined using purposive sampling, involving 16 respondents from various organizational levels (directors, managers, supervisors, and operational staff) to obtain a comprehensive perspective.

The independent variables included the implementation of Lean Management (waste elimination, value stream mapping, continuous improvement, standardization) and Resilience Engineering (adaptive capacity, anticipation capability, response capability, learning capability). The dependent variable was supply chain performance, measured through indicators such as lead time, capacity, productivity, cost efficiency, quality, customer satisfaction, and operational flexibility. Data were collected through Likert scale questionnaires, observations, semi-structured interviews, and company operational documents.

Quantitative analysis was conducted using descriptive statistics, paired t-tests, and percentage improvement analysis to measure performance changes. Qualitative data were analyzed using a thematic approach, then integrated to produce a comprehensive understanding of the impact of the integrated strategy. The study also paid attention to ethical aspects, including participant consent, the principle of voluntariness, and the protection of respondents' rights during the research process.

RESULTS AND DISCUSSION

The integration of lean management and resilience engineering has been proven to be able to improve supply chain performance by balancing efficiency and resilience. This approach allows for increased productivity without compromising flexibility, as well as strengthening resilience without sacrificing cost-effectiveness. As a result, a supply chain that is both lean and resilient in the face of uncertain business dynamics is created.

Sales Division

Prior to implementation, the sales division faced challenges in the form of the absence of structured sales targets, high customer churn, and low responsiveness to market demand, which led to inefficient information flow and inconsistent sales performance. Through the implementation of lean management, improvements are made by focusing on customer value, process standardization, elimination of waste, setting performance targets, and periodic

evaluations. Meanwhile, resilience engineering strengthens adaptive capabilities by improving service flexibility, customer monitoring, and refinement of feedback-based strategies and team performance evaluation. The integration of these two approaches creates synergy in increasing efficiency while strengthening the sales division's responsiveness to market dynamics. Lean management provides structure and standardization, while resilience engineering adds to the capacity for adaptation and recovery, resulting in a more efficient, responsive, and sustainable sales system.

Main impacts

Table 1. Main Impact of Sales Division

KPI	Before	After	Status
Strategy	No target	There is a target	Structured
Customer retention	Many customers are missing	Customers are monitored	Organized
Quality of service	Unresponsive	Fast and responsive	Structured
Monthly sales	-	Continue to increase	Increase

The implementation of the integration of lean management and resilience engineering in the sales division has resulted in significant improvements. Sales strategies are now more structured, customer retention increases through monitoring systems, and service quality is more responsive. The main impact is seen in the continuous increase in monthly sales, showing that this integration not only improves efficiency, but also strengthens the team's adaptability in the face of market dynamics and supports overall supply chain performance.

Operational standardization

Table 2. Operational Standardization

Parameter	Before	After	Status
SOUP	None	Fully available	Sales process Organized
Profit standard	None	Standard margin policy	Profitability guarantee
Documentation process	At least	Complete	Well documented
Quality standards	None	Available	Work benchmark

In terms of operational standardization, the initial condition without SOPs, profit standards, documentation, and quality standards has now changed to a complete and documented system. SOPs ensure an orderly sales process, margin policies ensure profitability, documentation strengthens evaluations, and quality standards become consistent work benchmarks.

Management and strategic plan

Table 3. Management and Strategic Plan

Aspects	Before	After	Status
Sales strategy	None	Structured	Clear direction and focus
Sales goals	None	Structured	Goal-oriented
Performance review	None	Quarterly Evaluation	Monitoring Sustainable
Strategic assessment	None	Quarterly Review	Systematic improvement

The implementation of lean management and resilience engineering has resulted in significant changes in the strategy and plan of the sales division. Previously untargeted sales strategies and goals are now structured with a focus on clear objectives, accompanied by

quarterly performance reviews that allow for continuous monitoring. The strategic assessment also runs systematically so that the improvement process can be carried out more targeted and sustainable, making the sales division more focused, adaptive, and consistent in achieving targets.

Customer relationship management

Table 4. Sales Division Customer Relationship Management

Aspects	Before	After	Status
Monitoring customer	None	Monitoring Periodic	Structured
Customer retention	Many customers are missing	Customer loyalty	Systematic improvement
Service response	Slow	Fast and responsive	Excellent service
Handling Complaint	Unstructured	Systematic and fast	Customer satisfaction

Lean–resilience integration also improves customer management systems. Customer monitoring is now structured and periodic, retention increases because customers are more loyal, and service responses become faster and responsive. The handling of complaints that were initially slow is now more systematic, resulting in increased customer satisfaction. These results prove that the sales division has transformed to be more responsive, adaptive, and oriented towards long-term customer loyalty.

Quality of customer relations

Table 5. Quality of Customer Relationships

Aspects	Before	After	Status
Customer service	Standard	Optimal	Competitive for profit
Response time	Slow	Fast and responsive	Customer satisfaction
Troubleshooting	Unresponsive	Proactive and solution-focused	Customer loyalty
Quality of service	Inconsistency	Strive to be consistent	Customer reputation

The application of lean management resilience engineering has a significant impact on customer relationships. Previously standard services are now more optimal and competitive, response times and problem resolution are faster and responsive, while service quality is improving consistent with a good reputation. This shows increased customer satisfaction and loyalty while strengthening trust and long-term relationships that are sustainable.

Sales performance and growth

Table 6. Sales Performance and Growth

Aspects	Before	After	Status
Sales quality	Low	Tall	Increase
Monthly sales	Standard	Increased	Increase
Sales effectiveness	Low	High performance	Increase
Market position	Weak	Reinforced	More competitive and strong

The lean–resilience approach also results in improved sales performance. The quality and effectiveness of sales that were previously low have now increased significantly, monthly sales continue to rise, and the market position has become stronger and more competitive. This change proves the optimization of resources and a more focused sales strategy, so that the sales division is able to maintain consistency of performance while expanding market share.

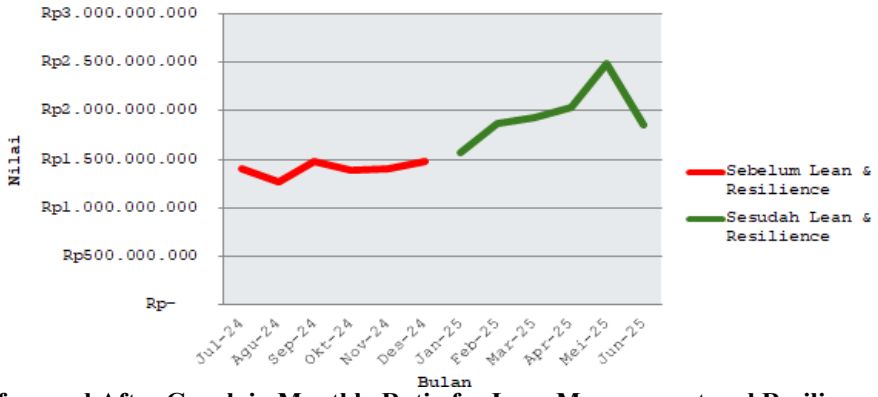


Figure 1. Before and After Graph in Monthly Ratio for Lean Management and Resilience Engineering Implementation

Based on the comparison graph, the implementation of lean management and resilience engineering shows a significant increase in sales. In the July-December 2024 period, sales tended to be stagnant with an average of IDR 1.26 billion, while after implementation (January-June 2025) it increased on average to IDR 1.95 billion with a peak of IDR 2.49 billion in May 2025. This proves that the integrative approach not only increases productivity and sales consistency, but also strengthens business resilience in the face of market dynamics.

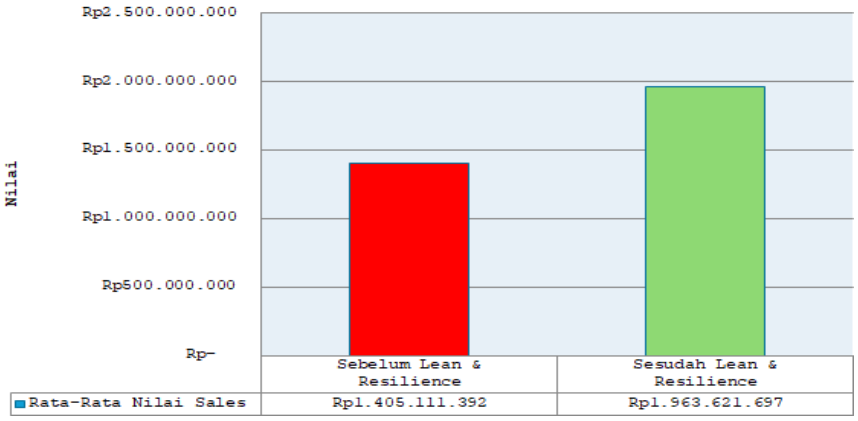


Figure 2. Graph of Six Months Before and After the Implementation of Management and Resilience Engineering

In the July-December 2024 period, the average sales were only IDR 1.40 billion and tended to be stagnant. After the implementation of lean management and resilience engineering in January-June 2025, the average sales increased to IDR 1.96 billion or an increase of 39.7%. This shows the real contribution of the strategy to efficiency, reduction of waste, and the adaptability of the company. This transformation brings a complete change to the sales division, from a more structured, documented and standardized strategy, to faster, systematic, and satisfaction- and loyalty-oriented customer service. Sales performance has also improved with better quality, sustainable growth, and a stronger market position. Overall, the integration of lean and resilience makes the sales division more efficient, resilient, and adaptive, while strengthening the company's overall supply chain performance.

Procurement Division

Prior to the integration of lean management and resilience engineering, the procurement division faced inefficiencies such as non-standard processes, long order processing times, and minimal documentation that led to supply delays and poor coordination with suppliers. Lean implementation focuses on eliminating waste and optimizing value streams, while resilience

engineering strengthens vendor diversification and adaptability to supply disruptions. As a result, the procurement system becomes more efficient in cost and time, as well as resilient in the face of market uncertainty.

Procurement process efficiency

Table 7. Procurement Process Efficiency

Aspects	Before	After	Status
Procurement process	Inefficient	High	Reached
Processing time per purchase order	30 Hours	5 Hours	Break down specifically

The implementation of lean and resilience in the procurement division accelerates the purchase order processing time from 30 hours to 5 hours (83% efficiency). This transformation suppresses non-value-added activities, improves coordination with suppliers, and strengthens supply resilience so that the supply chain is more efficient and adaptive.

Operational standardization

Table 8. Operational Standardization

Aspects	Before	After	Status
SOUP	None	Fully available	Process consistency increase
Process documentation	Minimal	Methodical	Well documented

Previously, without SOPs and documentation, now the procurement division has a documented system that is consistent, transparent, and easy to evaluate, so that the effectiveness of procurement management has increased significantly.

Supplier management

Table 9. Supplier Management

Aspects	Before	After	Status
Rating system Vendors	None	There is a scoring system	Vendor quality Guaranteed
Number of vendors	Few/limited	Diverse and diverse	Supply chain flexibility
Backup vendors	Hard to find	Easily accessible	Increased resilience

Supplier management is strengthened through a vendor evaluation system, increasing the number of vendors, and more transparent access to supplier data. These changes improve supply chain flexibility, ensure vendor quality, and build relationships that are more adaptive to market changes.

Organizational learning

Table 10. Organizational Learning

Aspects	Before	After
Learning from failure	None	Methodical
Continuous improvement	None	Implemented

The integration of lean management and resilience engineering in the procurement division has successfully transformed previously inefficient processes into faster, documented, and adaptive systems. Purchase order processing time is drastically reduced, SOPs and operational documentation are standardized, and supplier management is strengthened through systematic evaluation and vendor diversification. In addition, the learning mechanism from failures and continuous improvement improves the consistency and resilience of the supply

chain. These results show that the procurement division is not only more efficient in cost and time, but also more resilient in the face of market uncertainty.

Production Division

Prior to the integration of lean management and resilience engineering, the production division faced long lead times (24 hours), low capacity (6.67 tons/day), minimal productivity, and the absence of SOPs and structured schedules. Lean implementations focus on waste reduction, flow optimization, pull systems, and kaizen, while resilience engineering strengthens flexibility, workforce redundancy, and learning from failure. The synergy between the two results in a production system that is more efficient, adaptive, and responsive to supply chain dynamics.

Main impact

Table 11. Main Impact

Aspects	Before	After	Status
Production lead time	24 hours (20 tons)	11 hours (20 tons)	54% reduction
Daily capacity	6.67 tons/day	14.54 tons/day	117% increase
Hourly productivity	0.83 tons/h	1.81 tons/h	117% increase

Note: one 8 hour working day for one product item

The implementation of lean management and resilience engineering has succeeded in reducing production lead time from 24 hours to 11 hours, increasing capacity from 6.67 tons/day to 14.54 tons/day, and increasing productivity from 0.83 tons/hour to 1.81 tons/hour. These changes show a significant increase in capacity efficiency and productivity.

Operational efficiency

Table 12. Operational Efficiency

Aspects	Before	After	Status
Production process	Inefficient	More efficient	Simplified operation
SOUP	None	Fully available	Standardized process
Production schedule	Unclear	Systematically scheduled	Predictable output

The production process that was initially inefficient became more structured with complete SOPs and systematic production schedules, resulting in predictable output. This condition strengthens order, standards, and operational reliability to support sustainable supply chain performance.

Capacity

Table 13. Production Capacity

Aspects	Before	After	Status
Daily capacity	6.67 tons/day	14.54 tons/day	117% increase
Processing time	24 hours (20 tons)	11 hours (20 tons)	- 54%
Hourly production	0.83 tons/h	1.81 tons/h	117% increase

The integration of lean management and resilience engineering increased daily capacity from 6.67 tons to 14.54 tons (up 117%), with production time reduced from 24 hours to 11 hours (54% efficiency). Hourly productivity also increased from 0.83 tons to 1.81 tons. This confirms an increase in efficiency that not only increases output, but also speeds up the production process.

Product quality

Table 14. Product Quality

Aspects	Before	After	Status
Product failure rate	Often	Infrequently	Significant reduction
Quality consistency	Low	Tall	Upskilling

The previously frequent failure rate of the product was successfully suppressed to be sparse, while the consistency of quality increased. This shows an increase in expertise, skills, and reliability of the production process which has a direct impact on product quality and trust.

Operational flexibility

Table 15. Operational Flexibility

Aspects	Before	After	Status
Flexibility production	Unable	Able	Can be customized with demand
Order arrears	Buildup	Controlled	Reduce wait times
Response time	Slow	Fast	Better customer service

The production division became more flexible in adapting to demand, characterized by faster order fulfillment and reduced customer waiting times. This change creates services that are more responsive, adaptive, and able to adjust capacity according to the dynamics of market needs.

Human resource development

The production division has experienced a significant increase through learning systems and resilience engineering. Operators who were previously limited in skills are now multi-skilled and more flexible. HR management is effective, efficient, and able to maximize the potential of the workforce. A learning culture that did not exist before is now structured, thus supporting continuous improvement and improvement of production performance.

Infrastructure and equipment. The application of lean management and resilience engineering improves the condition of equipment from minimal to adequate, thereby supporting efficiency and operational capabilities. Production efficiency, which was originally low, is now increasing, supported by the optimization of resource use. This emphasizes the importance of infrastructure support to strengthen production performance in a sustainable manner. Differences in conditions before and after the implementation of lean management and resilience engineering, so that the impact of improvement can be shown more clearly and informatively.

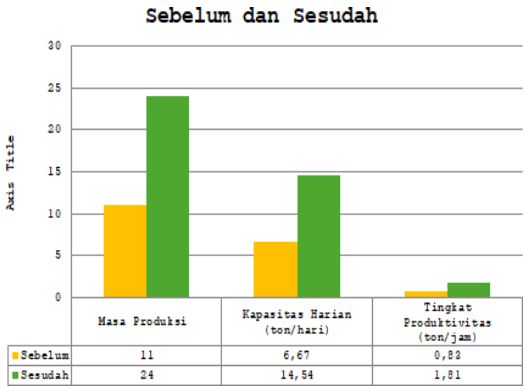


Figure 3. Production Division Results Summary Chart

The implementation of lean management and resilience engineering in the production division has a significant impact on supply chain performance. Lead time decreased by 54%,

daily capacity increased by 117%, and hourly productivity increased by 117%. Operational efficiency improves through process simplification, the availability of standardized SOPs, and a more systematic and predictable production schedule. Production capacity increased with the workaround time reduced from 24 hours to 11 hours, while quality improved through decreased failure rate and improved yield consistency. Operational flexibility is also more adaptive, demonstrated by controlling order arrears and faster responses. Human resource development also contributes, where operators now have multiple skills, more efficient management, and a culture of continuous learning is beginning to take shape. The production infrastructure, which was originally minimal, has also been updated to better support efficiency and resource utilization. Overall, this integration not only improves efficiency and productivity, but also strengthens quality, flexibility, human resources, and infrastructure, thereby creating sustainable and highly competitive supply chain performance.

Warehouse/Warehouse Division

Prior to the implementation of lean management and resilience engineering, the warehouse division faced limited capacity (≤10 tons), unsystematic layout, and low inventory data accuracy, resulting in material flow bottlenecks and reduced supply chain responsiveness. The implementation of lean management through the 5S methodology and waste elimination improves order, space efficiency, and process speed, while resilience engineering strengthens capacity flexibility, security, and data-based monitoring systems. The integration of these two approaches results in a warehouse that is more efficient in the use of space while being adaptive to the dynamics of supply and demand.

Main impact

Table 16. Main Impact

KPI	Before	After	Status
Total capacity	< 10 Tons	> 150 tons	1,400% Increase
Layout Warehouse	Untidy	Category last food	Organized
Data Accuracy	Inaccurate	Accurate	-

The implementation of lean management and resilience engineering in the Warehouse Division resulted in an increase in storage capacity of 1,400% with an escalation time of less than 10 minutes. This shows space efficiency, capacity planning optimization, and more precise data accuracy. Warehouse layouts that were previously unorganized have become systematic, minimizing waste of time and supporting more effective management of goods. Overall, these improvements improve the efficiency, orderliness, and precision of the warehousing process.

Warehouse organization and layout

Table 17. Warehouse Organization and Layout

Aspects	Before	After	Status
Arrangement of goods	Untidy	Neat and categorised	Access and identification easy
Stock classification	None	Organized according to classification	Optimized space utilization
Layout management	Irregular	Layout	Efficient workflow
Security classification	None	Harmful / not dangerous	Security compliance Improved

The application of lean management and resilience engineering in the organizational aspects and warehouse layout has resulted in significant improvements, including easier access to goods, faster stock identification, and improved work safety. A more orderly layout of goods and a clear classification system support operational efficiency and reduce the risk of work

accidents. In general, these improvements have an impact on the effectiveness of warehouse management, operational efficiency, and compliance with safety standards.
Stock management system

Table 18. Stock Management System

Aspects	Before	After	Status
SOUP	None	Complete Available	Standard operation
Stock listing	None	Methodical	Complete traceability
Data accuracy	Inaccurate	Accurate (Real Time)	Reliable decision-making
Stock Visibility	Unclear	Transparent	Better inventory control

The implementation of a stock management system increases the effectiveness of inventory control. With SOPs, stock recording is more systematic, data accuracy is increased, and stock visibility becomes transparent. This enables real-time decision-making, facilitates inventory control, and supports more effective supply chain performance.

Capacity

Table 19. Warehouse Capacity

KPI	Before	After	Status
Stock capacity	< 10 Tons	> 150 tons	1,400% Increase
Creating /disassembling	Slow	Fast	Organized
Space Utilization	Low	Optimal	Maximum efficiency

The lean management and resilience engineering approach provides a significant increase in warehouse capacity, from 10 tons to more than 150 tons (up 1,400%). The loading and unloading process that was initially slow became fast and organized, and the initially low use of space turned into optimal. This condition reflects maximum efficiency in storage, resource planning, and warehouse operational management.

Category Stock

Table 20. Warehouse Stock Category

Category	Definition	Strategy management
Fast movement	High-turnover goods	Priority placement easy access
Slow movement	Items with low turnover	Area Seconds
Dead movement	None/minimal movement	Sales planning

Grouping stocks by movement category improves the effectiveness of inventory management. Fast-moving items are placed in priority areas to speed up distribution, while slow-moving items are managed in secondary areas so as not to interfere with the main space. For dead moving goods, sales planning is carried out to avoid accumulation. This classification strategy is in line with the principles of lean management because it reduces space waste and supports resilience engineering through an adaptive stock management system.

Operational efficiency

Table 21. Operational Efficiency

Aspects	Before	After	Status
Tools and equipment	Minimalist	Adequate	Increased productivity
Material handling	Manual / lambat	Efficiency/fast	Faster process

Operational efficiency has increased significantly after the implementation of lean management and resilience engineering. Tools and equipment that were initially minimal are now more adequate, so that work productivity increases. Material handling that was previously manual and slow has become faster thanks to modern systems. This transformation supports

optimal resource utilization and creates efficient, reliable, and productive warehouse operational processes.

Learning and improvement

Table 22. Learning and Improvement of the Warehouse Division

Aspects	Before	After	Status
Learning culture	None	Learning system	Continuous improvement
Prevention Error	Reactive	Proactive	Risk mitigation

The implementation of lean management and resilience engineering in the Warehouse Division encourages the formation of a systematic learning culture, continuous improvement, and more proactive prevention strategies, thereby increasing operational effectiveness and organizational resilience in the face of risks. In the warehousing aspect, changes can also be seen from the placement of goods that were originally random, limited space, and the absence of classification into a more structured system, optimal space capacity, and systematic separation of dangerous goods and WIP, as shown in the following table.

Table 23. Warehouse Layout Optimization

Before	After
Random item placement	The classification is systematic
There is no categorization system	Fast/Slow/Off movement category
Finished Product/WIP Mix	Finished goods and separate WIP
No security classification	Separation of hazardous materials
Low room capacity	Optimized space utilization

The results of the warehouse layout optimization as shown in the Table above then have a significant impact on improving the overall performance of the warehouse division. The changes that have occurred are not only limited to the aspect of spatial planning, but also have implications for stock capacity, data accuracy, loading/unloading process speed, and security compliance. A summary of the performance results of the warehouse division before and after the implementation of lean management and resilience engineering is shown table 25.

Table 24. Summary of Warehouse Division Results

Performance Indicators	Before	After	Status
Stock Capacity	< 10 Tons	> 150 tons	1.400+
Data Accuracy	Less	Good	Increased
Layout Efficiency	Unorganized	Methodical	Transformasi
Loading/Unloading Speed	Slow	Fast	Increased
Security Compliance	At least	Better	Increased

The stock capacity graph shows a significant spike from less than 10 tonnes before the implementation of lean management and resilience engineering to more than 150 tonnes afterwards, confirming a substantial transformation in warehouse capacity utilization.

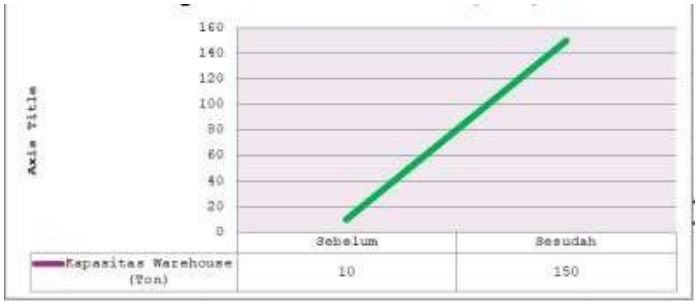


Figure 4. Warehouse Capacity

The results show that the implementation of lean management and resilience engineering in the Warehouse Division significantly increases stock capacity from <10 tons to >150 tons (up 1,400%), accompanied by systematic layout, structured arrangement and classification of goods, and more efficient workflows. A stock management system with SOPs, systematic record-keeping, real-time data, and transparent visibility strengthens inventory reliability, while the classification of goods movements supports distribution strategies and sales planning. The increase in efficiency is also reflected in adequate work equipment, faster material handling, and higher productivity. In addition, a learning culture is formed and error prevention mechanisms are transformed into proactive, thereby strengthening operational resilience. Overall, the integration of these two approaches creates an efficient, organized, accurate, and adaptive warehouse in the face of demand dynamics and potential supply chain disruptions.

Logistics/Operations Division

Prior to the implementation of lean management and resilience engineering, the logistics division faced delivery delays, high operational costs, inefficient distribution routes, and low customer satisfaction. The implementation of lean management is focused on optimizing value streams through route efficiency, fleet utilization, process standardization, and structured delivery planning with real-time monitoring. Meanwhile, resilience engineering strengthens adaptive capacity with fleet flexibility, alternative routes, contingency plans, and experiential learning systems. The integration of these two approaches results in significant transformation by creating a logistics system that is efficient, adaptive, and responsive to customer needs while being resilient to operational disruptions.

Main impact

Table 25. Main Impact

KPI	Before	After	Status
Customer complaints	Often	At least	Significant
Delivery performance	Often late	On time	Significant
Operating costs	Overprice	Optimal	Significant
Route efficiency	Inefficient	More efficient	Significant

The evaluation of the implementation of lean management and resilience engineering in the logistics division showed a significant increase in all KPIs. Customer complaints have decreased drastically, deliveries have been on time, operational costs have been more efficient, and distribution routes have been more optimal. Overall, the integration of these two approaches has been proven to significantly improve supply chain performance.

Customer service and delivery performance

Table 26. Customer Service and Delivery Performance

Aspects	Before	After	Status
Delivery timeliness	Often late	On time	Customer satisfaction
Customer complaints	Often	At least	Quality of service increase
Delivery schedule	Unstructured	Systematically scheduled	Predictable service
Service reliability	None	Consistent	Company reputation

The implementation of lean management and resilience engineering improves customer service through more timely delivery, structured schedules, reduced complaints, and service consistency, so that company satisfaction and reputation are increasing.

Operational standardization

Table 27. Operational Standardization

Parameter	Before	After	Status
SOUP	None	Fully available	Standard operation
Standard route	None	Standard price per route	Transparency fees
Documentation	At least	Complete	Knowledge management

SOPs, route standards, and documentation are now fully available, supporting more efficient, transparent, and sustainable operations.

Fleet and transportation management

Table 28. Fleet and Transportation Management

Matrix	Before	After	Status
Fleet availability	Often absent	Backup/expedition available	More robust operations
Transportation options	Limited	Have alternatives	Multiple solutions
Route planning	Inefficient	The route Optimize	Cost-effective
Fleet monitoring	None	Exist	Full visibility

The availability of spare fleets, transportation alternatives, optimal routes, and real-time monitoring improve distribution reliability and operational efficiency.

Cost management and efficiency

Table 29. Cost Management and Efficiency

Aspects	Before	After	Status
Operating costs	Cost overruns	Cost optimized	Control Budget
Route efficiency	Inefficient	More efficient	Fuel and time savings
Pricing structure	Non-standard	Standard Rate for route	Fees that can be Predictions
Cost control	Reactive	Proactive	Financial Discipline

Operational costs are controlled through route efficiency, standard rates, and proactive controls, resulting in significant savings and stronger competitiveness.

Resilience and contingencies

Table 30. Resilience and Contingency

Parameter	Before	After	Status
Fleet backup	None	Expedition as a backup	Continuity of service
Alternative options	Limited	Various modes transportation	Risk mitigation
Contingency Planning	Manual/lambat	Systematic backup plan	Business continuity

Backup expeditions, diverse modes of transportation, and systematic contingency planning strengthen supply chain adaptation to disruptions.

Technology and monitoring

Table 31. Technology and Monitoring

Aspects	Before	After	Status
Fleet tracking	None	Realtime	Visibility Operational
Schedule Management	Manual	Structured	Efficient planning
Communication	Coordinated bad	Coordinated Improved	Effective communication Improved

Real-time tracking, structured scheduling, and better communication create transparency, efficiency, and effective operational coordination. In addition to the technological aspect, the implementation of lean management and resilience engineering also has a direct impact on operational performance. The difference in conditions before and after the implementation of the strategy can be seen in the following table.

Table 32. Summary of Operational Division Results

Performance Indicators	Before	After	Status
Customer Complaints	Frequent/High	At least	Increased
Shipping Constraints	Frequent/High	At least	Increased
Route Efficiency	Low	Dioptimalkan	Transformasi
Operating Costs	Swell	Controlled	Transformasi
Fleet Utilization	At least	Maximized	Increased

The integration of lean management and resilience engineering has been proven to improve supply chain performance in the logistics and operational divisions. Improvements can be seen in reducing customer complaints, delivery accuracy, route efficiency, cost optimization, operational standardization, and fleet management. System resilience is also strengthened through backup fleets, transportation alternatives, contingency planning, real-time monitoring technology, structured schedules, and effective communication. Overall, these two approaches not only reduce waste and increase efficiency, but also strengthen the company's adaptability, continuity of service, and competitive advantage.

Assessment of Lean Management and Resilience Engineering Integration from the Beginning of the Process to the End of the Process

A thorough analysis was conducted to assess the impact of the implementation of lean management and resilience engineering, not only on each division individually but also on the interconnectedness between divisions in the supply chain. Evaluation was carried out through a before-after questionnaire to 16 respondents across the hierarchy (directors, managers, supervisors, staff) to obtain a comprehensive perspective. This multi-level sampling approach ensures the validity and reliability of the data and enables end-to-end assessment from procurement to sales. The results of the assessment are then classified using a standardized scoring system to compare the organization's performance before and after implementation.

The performance classification system uses a five-strata ordinal scale based on a maximum score of 500 points converted to percentages. The categories consist of Very Need for Improvement (0–30%), Need Improvement (30–49%), Adequate (50–69%), Good (70–79%), and Very Good (80–100%), which reflects the level of maturity of the organization in the implementation of lean management and resilience engineering. The distribution of score intervals is arranged in stages to confirm the difference in complexity at each level of achievement. As a preliminary overview, the assessment was conducted in five main divisions (sales/marketing, procurement, production, warehouse, and operations) to map the existing conditions and identify performance gaps before the implementation of the Lean–Resilience integrative strategy.

The baseline results in Table 34 show that organizational performance is in the Need for Improvement category with an average score of 195.12 out of 500 points (39%), where directors recorded the highest scores, followed by managers, supervisors, and staff. These findings confirm that organizations have not achieved optimal implementation of lean management and resilience engineering, requiring integrated strategic interventions. Therefore, the research continues at the lean–resilience implementation stage with a series of systematic

steps, which are then re-evaluated using identical measurement instruments to comparatively assess the impact of the intervention.

Table 33. Form Results After Implementation of Lean Management and Resilience Engineering

Name	Position	Lean Management	Resilience Engineering	Division Integration	Overall Integration	Total
Anshori, S.T.	Director	124	131	56	60	371
Andi, S.E.	Mnj. Marketing	116	125	52	58	351
Umsira	Mnj. Production	116	125	52	54	347
M Revelation Fauzi, S.T.	Mnj. Warehouse	116	125	52	54	347
Lulu Nuraeni, S.E.	Mnj. Procureme nt	116	125	52	56	349
Egi Mulyanto	Mnj. Logistics	116	125	52	50	343
Mutia Syafitri, S.Ak.	Spv. Procureme nt	115	123	49	52	339
Anang Culture M	Spv. Warehouse	115	123	49	50	337
Rizky Madani	Spv. Production	115	123	49	54	341
Eva Praise, A.Md.	Spv. Marketing	115	123	49	52	339
Adi Nugroho	Spv. Logistics	115	123	49	50	337
Firza Maulana, S.P.	Marketing Staff	114	121	50	52	337
Henry	Production Staff	114	121	50	55	340
Suparman	Staf Procureme nt	114	121	50	56	341
Junaidi	Staff Logistics	114	121	50	55	340
Hendra	Staff Warehouse	114	121	50	53	338
Total						**5.497**
Average						**343,56**
Percentage						**69%**

The results of the post-implementation evaluation in Table 34 show a significant increase in organizational performance from the category of Need for Improvement (39%) to Adequate (69%) with an average score of 343.56 points. All levels of the hierarchy have seen a consistent increase, with directors reaching the Good category (371 points) and other levels in the Adequate range. The pre- and post-implementation comparison showed a spike in total scores from 3,122 to 5,497 points (+2,375), while narrowing the gap between levels. These findings confirm the effectiveness of lean management–resilience engineering integration in improving efficiency, strengthening system resilience, and creating uniform standards of understanding and application across all levels of the organization.

CONCLUSION

The study demonstrated that integrating Lean Management and Resilience Engineering significantly enhanced supply chain performance, increasing the overall score from 195.12 (Need Improvement) to 343.56 (Sufficient). Improvements were observed in all divisions, including a 39.7% increase in sales, an 83% acceleration in procurement purchase orders, a 54% reduction in production lead time with a 117% rise in productivity, a 1,400% expansion in warehouse capacity, and notable reductions in logistics complaints and costs. The lean–resilience synergy fostered an efficient and adaptive system, balancing waste elimination with robust resilience, and offering a practical framework for manufacturing organizations seeking

sustainable competitive advantage through cross-hierarchical commitment and continuous learning. Future research could explore the applicability of this integrated approach in different industries, such as healthcare or service sectors, and examine long-term impacts on organizational adaptability under varying market conditions.

REFERENCES

Anderson, M., Taylor, D., & Wilson, E. (2025). Menuju resiliensi: Pemetaan dan eksplorasi literatur tentang manajemen lean. *Jurnal Internasional Lean Six Sigma, 16*(3), 445–468.

Bernhard, O., Dillinger, F., & Zäh, M. (2023). Metodologi untuk proses transformasi dalam konteks lean 4.0 di perusahaan manufaktur. *Procedia CIRP, 120*, 487–492. https://doi.org/10.1016/j.procir.2023.09.024

Chen, L., Wang, S., & Liu, H. (2024). Resiliensi rantai pasokan: Tinjauan dari perspektif manajemen inventori. *Jurnal Internasional Ekonomi Produksi, 45*(2), 123–145.

Garcia-Buendia, N., Moyano-Fuentes, J., Maqueira-Marín, J. M., Romano, P., & Molinaro, M. (2025). Kinerja pemasok strategis dalam lanskap kompetitif: Meningkatkan kinerja organisasi melalui manajemen rantai pasokan lean. *Jurnal Internasional Operasi & Manajemen Produksi.*

Iyer, K. N. S., Srivastava, P., & Srinivasan, M. (2020). Implikasi kinerja lean dalam rantai pasokan: Mengeksplorasi peran orientasi pembelajaran dan sumber daya relasional. *Jurnal Internasional Ekonomi Produksi, 216*, 94–104.

Johnson, A., Smith, B., & Brown, C. (2024). Pengaruh rantai pasokan lean terhadap keunggulan kompetitif: Tinjauan literatur sistematis. *Cogent Business & Management, 11*(1), 2370445.

Klein, L. L., Vieira, K. M., Feltrin, T. S., Pissuti, M., & Ercolani, L. (2022). Pengaruh praktik manajemen lean terhadap efektivitas proses: Studi kuantitatif di lembaga publik. *SAGE Open, 12*(1), 1–14. https://doi.org/10.1177/21582440221088837

Kumar, S., Patel, N., & Sharma, V. (2024). Fleksibilitas rantai pasokan dan resiliensi pasca-pandemi. *Jurnal Global Manajemen Sistem Fleksibel, 25*(2), 245–267.

Lee, S., Kim, J., & Park, H. (2024). Meningkatkan resiliensi rantai pasokan melalui pendekatan jaringan pasokan. *Journal of Business & Industrial Marketing, 39*(8), 1678–1695.

Maqueira-Marín, J. M., Moyano-Fuentes, J., & Bruque, S. (2023). Respons manajemen rantai pasokan lean terhadap ketidakpastian teknologi: Konsekuensi untuk kinerja operasional dan daya saing. *Jurnal Manajemen Teknologi Manufaktur, 34*(1), 67–89.

Martinez, P., Lopez, A., & Garcia, R. (2021). Memperluas manajemen lean sepanjang rantai pasokan: Dampak terhadap efisiensi. *Jurnal Manajemen Teknologi Manufaktur, 32*(1), 63–84.

Nakamura, T., Sato, K., & Yamamoto, H. (2022). Pendekatan terintegrasi resilience engineering–lean management untuk penilaian dan peningkatan kinerja departemen klinis. *Socio-Economic Planning Sciences, 84*, 101269.

OECD. (2025). *Tinjauan resiliensi rantai pasokan OECD: Lingkungan kebijakan untuk resiliensi rantai pasokan.* OECD Publishing.

Patel, R., Kumar, A., & Singh, B. (2022). Meningkatkan resiliensi rantai pasokan melalui industri 4.0: Tinjauan literatur sistematis di bawah kesan pandemi COVID-19. *Computers & Industrial Engineering, 168*, 108099.

Pawar, B., Huffman, M., Khan, F., & Wang, Q. (2022). Kerangka penilaian resiliensi untuk sistem proses respons cepat. *Keselamatan Proses dan Perlindungan Lingkungan, 163*, 82–93.

Rodriguez, C., Martinez, F., & Gonzalez, A. (2021). Integrasi paradigma lean dan resiliensi: Tinjauan sistematis mengidentifikasi arah penelitian saat ini dan masa depan. *Sustainability, 13*(16), 8893.

Thompson, J. (2025). Menyeimbangkan biaya dan resiliensi: Tantangan baru rantai pasokan. *Harvard Business Review, 103*(4), 78–85.

Williams, R., Thompson, K., & Davis, M. (2025). Menuju rantai pasokan yang resilient dan viable: Model multidimensional dan analisis empiris. *Jurnal Internasional Penelitian Produksi, 63*(8), 2847–2865.

Xue, J., & Li, G. (2023). Balancing resilience and efficiency in supply chains: Roles of disruptive technologies under Industry 4.0. *Frontiers of Engineering Management*, *10*(1), 171–176.

Zhang, Y., Li, X., & Wang, Q. (2025). Optimalisasi kinerja organisasi pariwisata kesehatan: Pendekatan terintegrasi berdasarkan resilience engineering dan kecerdasan emosional. *Human Factors and Ergonomics in Manufacturing & Service Industries, 35*(3), 234–251.