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An Integrated Lean and VRP Model for Reducing Logistics Costs in MSMEs: A Review Study

Wan Habibi Rahman Barus[*1], Nadiya Maharani[1], Fadil Abdullah[1], Muhammad Alif Ihsan[2]
[1]*Logistics Engineering Technology, Politeknik META Industri Cikarang, Bekasi, 17530, Indonesia*
[2]*Industrial Engineering, Politeknik META Industri Cikarang, Bekasi, 17530, Indonesia*
[*]Corresponding Author: wan@politeknikmeta.ac.id

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ABSTRACT
This study aims to synthesize the literature on the integration of Lean Logistics and the Vehicle Routing Problem (VRP) in reducing logistics costs for Micro, Small, and Medium Enterprises (MSMEs) in Indonesia, as well as to formulate a conceptual framework for an integrated model that aligns with the characteristics of MSMEs. The method used was a systematic literature review, with a literature selection procedure involving identification, screening, and assessment of suitability from the Google Scholar and Scopus databases, as well as university repositories. Ten selected articles were analyzed using a thematic approach to identify patterns, similarities, differences, and research gaps. The synthesis results indicate that the separate application of Lean and VRP has proven effective in reducing distribution costs, yielding distance savings of 15-60% and cost savings of 15-40%; however, the integration of these two approaches into a single unified model remains rare among Indonesian MSMEs. This study proposes a conceptual framework for a sequential Lean-VRP integration model consisting of four stages: identification and elimination of waste using Value Stream Mapping; VRP modeling that accounts for residual waste; simulation and validation; and implementation and continuous improvement. The contribution of this research is to provide a conceptual framework that is adaptable to the resource constraints of SMEs and serves as a foundation for the development of integrated mathematical models in future research.

Keyword: *Lean Logistics, Logistics Costs, Model Integration, MSMEs, Vehicle Routing Problem*

ABSTRAK
Penelitian ini bertujuan untuk mensintesis literatur tentang integrasi *Lean Logistics* dan *Vehicle Routing Problem* (VRP) dalam penurunan biaya logistik pada Usaha Mikro, Kecil, dan Menengah (UMKM) di Indonesia serta merumuskan kerangka konseptual model terintegrasi yang sesuai dengan karakteristik UMKM. Metode yang digunakan adalah *systematic literature review* dengan prosedur seleksi literatur melalui identifikasi, penyaringan, dan penilaian kelayakan dari basis data Google Scholar, Scopus, dan repositori universitas. Sepuluh artikel terpilih dianalisis menggunakan pendekatan tematik untuk mengidentifikasi pola, kesamaan, perbedaan, dan celah penelitian. Hasil sintesis menunjukkan bahwa penerapan Lean dan VRP secara terpisah terbukti efektif menurunkan biaya distribusi dengan penghematan jarak 15-60% dan biaya 15-40%, namun integrasi kedua pendekatan dalam satu model terpadu masih jarang dilakukan pada UMKM Indonesia. Penelitian ini menghasilkan usulan kerangka konseptual model integrasi Lean-VRP sekuensial yang terdiri dari empat tahap: identifikasi dan eliminasi *waste* menggunakan *Value Stream Mapping*, pemodelan VRP dengan mempertimbangkan sisa *waste*, simulasi dan validasi, serta implementasi dan perbaikan berkelanjutan. Kontribusi penelitian ini adalah menyediakan kerangka konseptual yang adaptif terhadap keterbatasan sumber daya UMKM dan menjadi dasar bagi pengembangan model matematis terintegrasi pada penelitian selanjutnya.

Keyword: Biaya Logistik, Integrasi Model, Lean Logistics, UMKM Vehicle Routing Problem

1. Introduction

MSMEs are key players in the national development process, playing a vital role in the country's economic growth and employment generation [1]. Micro, Small, and Medium Enterprises (MSMEs) are an important pillar of the Indonesian economy, particularly in labor-intensive sectors such as manufacturing and the distribution of consumer products [2]. However, MSMEs face acute logistical challenges due to heterogeneous customer demand, limited production capacity, and rising transportation expenses. Distribution systems that remain conventional result in long distances and high operating costs, thereby squeezing MSMEs' profit margins [3].

Logistics and transportation are the backbone of global trade, and the efficiency of these systems is crucial for economic growth, supply chain reliability, and customer satisfaction. In this context, the role of operations research and optimization is becoming increasingly important, providing analytical tools to address complex logistics challenges and improve operational performance [4]. The two main approaches that have proven effective in improving logistics efficiency are Lean Logistics and the Vehicle Routing Problem (VRP)[5]–[7].

Lean Logistics focuses on reducing waste and optimizing logistics processes by applying the principles of efficiency and increasing value-added activities throughout the supply chain [8]. His approach emphasizes the importance of continuous improvement to achieve maximum efficiency and meet customer expectations on time and in the right quantities [9]. The Milk Run System approach, as one implementation of Lean, has proven effective in reducing unnecessary trips and improving operational efficiency [10].

Meanwhile, the Vehicle Routing Problem (VRP) is a complex combinatorial optimization problem whose primary objective is to determine the optimal route for vehicles to distribute goods from a depot to customers, thereby minimizing total costs, which are heavily influenced by travel distance and the number of vehicles used [6], [11]. Research shows that route optimization has a direct impact on reducing total distribution costs

[12]. Studies have demonstrated that VRP implementation in distribution networks can significantly reduce travel distances and vehicle usage, thereby improving logistics cost efficiency [13]. However, the adoption of such optimization practices remains rarely implemented by MSMEs in Indonesia, particularly due to limited technical capacity, data availability, and awareness of potential benefits.

Although research on Lean and VRP has progressed, integrated applications of these two approaches in the context of MSMEs, particularly in Indonesia, are still rare. The existing literature tends to discuss each approach separately or focus on large-scale companies. Therefore, a literature synthesis is needed to formulate a conceptual framework for an integrated Lean and VRP model for reducing logistics costs that is tailored to the characteristics and constraints of MSMEs in Indonesia. This article aims to: (1) identify and synthesize the literature on the application of Lean and VRP in the context of SME logistics; (2) analyze research gaps and implementation challenges in Indonesia; and (3) formulate a proposed conceptual framework for an integrated Lean-VRP model for SMEs.

2. Research Methodology

This study employs a systematic literature review approach to examine and synthesize the integration of Lean Logistics and the Vehicle Routing Problem (VRP) in reducing logistics costs for Micro, Small, and Medium Enterprises (MSMEs), particularly in the Indonesian context. This approach was selected because it provides a comprehensive overview of the current state of knowledge while also highlighting new perspectives and unanswered questions, without being overly constrained by rigid systematic review protocols [14], [15]. The methodology is structured into five main stages: (1) literature selection procedure, (2) quality appraisal, (3) data extraction, (4) data analysis techniques, and (5) analytical framework.

2.1. Literature Selection Procedure

The literature review process was conducted systematically through several stages, including identification, screening, eligibility assessment, and final selection of articles. Scientific articles were collected from leading academic databases such as Google Scholar, Scopus, and university repositories. The keywords used include a combination of: “Lean Logistics,” “Vehicle Routing Problem,” “VRP,” “UMKM,” “MSMEs,” “Indonesia,” “distribution,” “logistics cost efficiency,” and “route optimization.” The literature search focused on studies discussing the application of Lean and VRP in the context of logistics and distribution, particularly in micro, small, and medium-sized enterprises [16]–[21]. This search string was applied to article titles, abstracts, and keywords. The search was conducted between January and March 2026. Additionally, manual snowballing searches were performed by reviewing the reference lists of selected articles to identify potentially relevant studies not captured by the initial database search. The inclusion criteria for this study are as follows:

a. Articles discussing the application of Lean or VRP in the context of logistics and distribution.

b. Case studies or research involving MSMEs or small-to-medium-sized enterprises.

c. Articles published in accredited national or international scientific journals, conference proceedings, or accredited research reports.

d. Articles available in Indonesian or English.

The exclusion criteria include:

a. Studies focusing on large-scale industries with no relevance to MSMEs.

b. Articles that do not discuss cost or operational efficiency aspects.

c. Publications that have not undergone peer review or editorial review, and unpublished reports.

d. Articles that are not available in full text.

The literature selection process is described below:

Stage 1: Identification A total of 42 articles was identified through the initial database search using the specified search string.

Stage 2: Screening After removing duplicates (n = 6), the titles and abstracts of the remaining 36 articles were screened for relevance to the research topic. Articles that did not address both logistics distribution and MSME contexts were excluded (n = 8). This stage yielded 28 articles that met the preliminary eligibility criteria.

Stage 3: Eligibility Assessment The full texts of the 28 articles were retrieved and assessed against the inclusion and exclusion criteria. Articles that did not present empirical data or quantitative results (n = 6), articles that focused solely on Lean or solely on VRP without any integration or comparison (n = 8), and articles with weak methodological quality (n = 4) were excluded. This stage yielded 10 articles that met all eligibility criteria.

Stage 4: Final Selection The final sample of 10 articles was selected for comprehensive analysis and synthesis. These articles were chosen based on the following additional criteria:

a. Studies that provided quantitative data on cost savings or efficiency improvements.

b. Studies that explicitly discussed either integration or comparison between Lean and VRP approaches.

c. Studies conducted in the context of MSMEs or small-scale distribution systems, preferably in developing countries or similar contexts.

d. Studies with clearly described methodologies and reproducible findings.

2.2. Quality Appraisal

To ensure the reliability and validity of the synthesized findings, each of the 10 selected articles underwent a quality appraisal using adapted criteria based on the framework proposed by [22] and [14]. The appraisal criteria evaluated the following dimensions:

Table 1. Quality Appraisal Criteria

Quality Dimension	Assessment Criteria
Clarity of Objectives	Are the research objectives clearly stated?
Appropriateness of Methodology	Is the methodology suitable for addressing the research questions?
Data Quality	Are the data collection and analysis methods described in sufficient detail?
Validity of Findings	Are the conclusions supported by the evidence presented?
Relevance to MSMEs	Does the study specifically address MSME characteristics and constraints?

Each article was rated on a scale of 1 (low) to 3 (high) for each dimension. Articles scoring below the threshold were discussed among the authors to reach a consensus on inclusion. All 10 selected articles received quality scores above the acceptable threshold (average score > 2.0). This quality appraisal process ensured that only studies with sufficient methodological rigor were included in the final synthesis.

2.3. Data Analysis Techniques

The selected literature was analyzed using a thematic approach to identify patterns, similarities, differences, and research gaps [23], [24]. The analysis process consisted of several stages:

a. Compare: identifying similarities in approaches and findings across studies

b. Contrast: noting differences in methods, contexts, and results

c. Criticize: evaluating the weaknesses and limitations of existing research

d. Synthesize: integrating findings to form new insights

e. Summarize: presenting conclusions from the entire body of literature

2.4. Analytical Framework

The analysis was conducted by grouping the literature into three main categories, such as Application of Lean Logistics in MSMEs, Application of VRP in MSME distribution optimization and Efforts to integrate the two approaches.

Based on the analysis results, a proposed conceptual framework for an integrated Lean-VRP model tailored to the context of Indonesian MSMEs was formulated. This framework synthesizes key findings from the reviewed literature and proposes a structured approach to reducing logistics costs that takes into account the unique characteristics and limitations of micro, small, and medium-sized enterprises in Indonesia.

2.5. Analytical Framework and Conceptual Model Development

Based on the thematic synthesis, the literature was organized into three categories to structure the analysis:

Category 1: Lean Logistics in MSMEs, Studies that applied Lean principles to identify and eliminate waste in MSME logistics operations. This category focuses on the types of waste commonly found in MSME distribution systems and the tools used to address them.

Category 2: VRP in MSME Distribution, Studies that applied VRP algorithms to optimize distribution routes for small-scale enterprises. This category examined the algorithms used, computational approaches, and reported efficiency improvements.

Category 3: Integrated Lean-VRP Approaches, Studies that attempted or proposed integration between Lean principles and VRP optimization. This category analyzed the methods, benefits, and challenges of different integration approaches[25].

A general framework for the integration of Lean Logistics and the Vehicle Routing Problem (VRP) is illustrated in Figure 1. Based on Figure 1, the steps for Lean-VRP integration are described as follows:

1. Logistics processes of MSMEs are identified using the Lean Logistics concept. The types of waste identified include waiting time, unnecessary transportation, under-utilized vehicles, and defective shipments [23]. Data on waste is collected from literature reviews, observations in previous studies, or documented empirical studies. This step aims to capture the dominant dimensions of waste in SME distribution as the foundation for designing a model to reduce logistics costs[26].

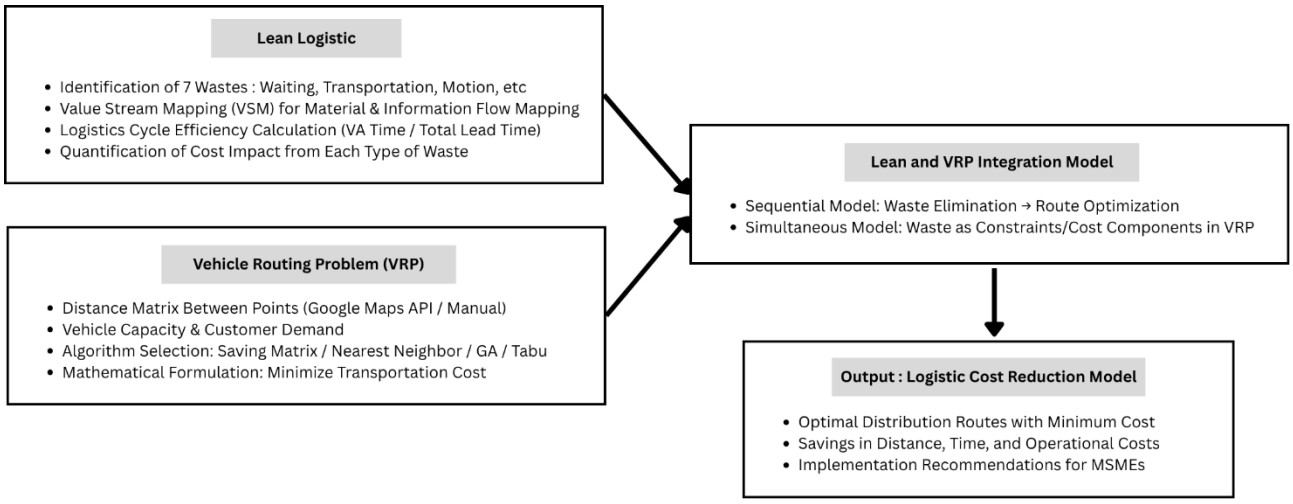


Figure 1. Framework for Integrating Lean Logistics and the Vehicle Routing Problem (VRP)

2. Distribution-Data-Based VRP Analysis: A structured VRP analysis was conducted using a combinatorial optimization approach. The first stage focused on translating distribution data (customer locations, demand, vehicle capacity, and time windows) into a distance matrix and a mathematical model formulation [27]. The second stage identifies the critical technical characteristics that require optimization priority, such as selecting the appropriate algorithm (Saving Matrix, Nearest Neighbor, Sweep Algorithm, or Genetic Algorithm) to minimize total travel distance, the number of vehicles, and transportation costs [28].

3. Development of a Conceptual Integration Model: Based on the results of the Lean and VRP analyses, a conceptual integration model was developed. This stage defines two integration approaches that can be applied to MSMEs [6], [24]. Sequential Model (Lean → VRP): This approach first applies Lean principles to identify and eliminate waste in the logistics process. Once waste has been minimized, VRP is then applied to optimize distribution routes based on the improved conditions. This approach is simpler and easier to implement, making it suitable for MSMEs with limited data and resources [29]; Simultaneous Model (Lean + VRP): This approach integrates Lean principles directly into the VRP formulation, where waste such as waiting time and vehicle under-utilization is incorporated as constraints or additional cost components in the optimization objective function. This model produces more comprehensive solutions but requires higher computational complexity and more detailed data.

4. Model Evaluation and Cost-Saving Potential: The proposed model was evaluated by reviewing previous studies that implemented Lean-VRP integration. The evaluation included a comparison of existing routes with proposed routes, as well as calculations of savings in mileage, distribution time, and total logistics costs [10][30]. The evaluation tools used included comparative analysis, percentage savings calculations, and case studies of various SMEs reported in the literature.

2.6. Methodological Limitations

This study has several methodological limitations that should be acknowledged:

Table 2. Limitations of the Study

Limitation	Description
Small Final Sample	The final sample of 10 articles, while sufficient for a narrative synthesis, limits the generalizability of findings. A larger sample would strengthen the evidence base.
Database Coverage	The search was limited to five databases and may not have captured all relevant articles published in regional or non-indexed journals.
Publication Bias	The study may be subject to publication bias, as studies with positive or significant results are more likely to be published than those with null findings.
Heterogeneity of Studies	The selected studies used diverse methodologies, contexts, and metrics, making direct comparison and meta-analysis difficult.
Conceptual Nature of Framework	The proposed Lean-VRP integration framework is conceptual and has not been empirically validated in real-world MSME settings. Practical claims should be treated with caution until empirical validation is conducted.

These limitations are framed as opportunities for future research, particularly in conducting empirical case studies and validation studies of the proposed framework in Indonesian MSME contexts.

3. Result and Discussion

This study is a literature review aimed at synthesizing various findings from previous studies on the application of Lean Logistics and the Vehicle Routing Problem (VRP) in the context of reducing logistics costs, particularly for MSMEs. From the ten journals that were analyzed in depth, various patterns, similarities, differences, and research gaps were identified, which served as the basis for formulating a conceptual framework for a Lean-VRP integration model for Indonesian MSMEs.

3.1. The Effectiveness of Identifying Waste as a First Step in Reducing Logistics Costs

The reviewed studies consistently demonstrate that waste identification through Lean approaches serves as a critical foundation for logistics cost reduction. Three dominant types of waste emerged across the studies: Waiting Time, Unnecessary Transportation, and Motion, which together account for the majority of inefficiencies in MSME distribution systems.

Gusta et al.[24] identified waste in industrial hose distribution using Process Activity Mapping (PAM), Value Stream Mapping (VSM), and questionnaires. The study found a total lead time of 144 hours, with Waiting, Motion, and Transportation as the primary waste categories. Proposed improvements included document digitization, warehouse layout improvements, route optimization, and rescheduling of loading operations.

Similarly, Camellia et al. [31] applied Lean Logistics, Kaizen, and PDCA at PT XYZ to identify the 7 Wastes in cable manufacturing. Through Root Cause Analysis (RCA), the primary causes were identified as inefficient interdepartmental coordination, a semi-manual administrative system, and limited logistics facilities. This study highlights that organizational and administrative factors often contribute more significantly to logistics waste than purely operational factors, particularly in MSME contexts where formal systems are underdeveloped.

Proença et al. [32] demonstrated that Lean tools in the horticulture industry reduced cycle time by 35.5% and lead time by 10.6%. The Lean approach proved effective in eliminating waste, reducing unnecessary movement, adapting layout, and leveling inventory. This study also increased supplier involvement in continuous improvement, indicating that Lean benefits extend beyond internal operations to supply chain partners.

Consistent with these findings, Amaral et al. [33] implemented the PDCA cycle using SIPOC, 5S, and visual management tools in an automotive manufacturing company. Transportation waste was reduced by optimizing material placement on logistics trailers, and an Excel-based simulator provided optimal cycle times. The milk-run assembly line approach proved crucial for integrating inventory management and facilitating communication between areas.

3.2. Application of the Vehicle Routing Problem for Distribution Optimization

Payungi's study [34] at PT RTP used the Nearest Neighbor algorithm as an initial solution and Tabu Search as the optimal solution. The results showed a total distance reduction of 33% and a time reduction of 15% compared to the previous route. The combination of heuristic and metaheuristic methods proved to yield better solutions.

A study on Srikandi MSMEs conducted by Hasdi et al [33] compared the Clarke and Wright Savings (CWS) method and the Cluster First Route Second (CFRS) method, with CFRS demonstrating greater efficiency, covering a distance of 94.1 km and incurring a cost of Rp88,550 on the first route. Total fuel cost savings reached Rp140,939 compared to the initial conditions. CFRS is recommended as the optimal solution for SMEs.

3.3. Integration of Lean Logistics and VRP within a Single Framework

The study conducted by Alvariedz et al [35] at Supplier X in Lembang is a concrete example of the integration of Lean Logistics and VRP. This study identified distribution efficiency issues resulting from a conventional delivery system, which led to high mileage and operational costs. Through the implementation of a Lean Logistics-based Milk Run System and the VRP method using the Nearest Neighbor algorithm, this study successfully demonstrated a reduction in travel distance from 101.8 km to 41.3 km [35]. Travel time was reduced to 99.12 minutes, and distribution costs fell from Rp326,800 to Rp267,700 per day. This study recommends the implementation of a lean-based integrated distribution system as a strategy for improving logistics efficiency [10].

A study conducted by Yudastio and Arieon [36] exploring the implementation of technology-based distribution management and lean principles at four companies yielded comprehensive results. The implementation of technologies such as Warehouse Management Systems (WMS) and automated route planning can significantly reduce lead times and shipping costs, with an average reduction of 20-30% in delivery times and 15-25% in operating costs [36]. The application of lean distribution principles-which emphasize efficient inventory management and pull systems-has been shown to reduce waste by up to 40% and inventory by up to 35%. However, the implementation of technology and lean distribution also faces obstacles such as limitations in technological infrastructure and the need for human resource training [38].

3.4. Comparison of Method and Algorithm Effectiveness

Based on a synthesis of the ten journals analyzed, there is a variety of methods and algorithms used in distribution optimization. The Nearest Neighbor method proved effective as an initial route-construction method due to its ease of implementation, while Tabu Search provided an optimal solution with a 33% distance savings and a 15%-time savings [32]. The Cluster First Route Second (CFRS) method demonstrated better efficiency compared to the Clarke and Wright Savings (CWS) method in the case of the Srikandi MSME, with a total fuel cost savings of Rp140,939. Research by Rahman et al [38] on Genetic Algorithms and Ant Colony Optimization also showed competitive results, with total distances of 54 km and 42.6 km, respectively, in the Dea Modis SME case.

The Heterogeneous VRP model in the study by Oktafianto and Arvitrida [39] incorporating Simultaneous Pickup and Delivery and Time Windows, and applied to PT Siklus Refil Indonesia, yielded a cost savings of 31.28%. This demonstrates that VRP variants that account for real-world operational complexities-such as vehicle heterogeneity, simultaneous pickup and delivery, and time windows-can provide more realistic and optimal solutions. The selection of the appropriate method depends heavily on the complexity of the problem, data availability, and the distribution characteristics of MSMEs [11], [40].

Table 3. Summary of Comparative Research Findings

Reference	Research Focus	Methods Used	Main Findings	Contribution
Alvariedz et al (2025)	Integration of Lean and VRP in Cabbage Distribution	Milk Run System, Lean Logistics, VRP Nearest Neighbor	The implementation of Lean-VRP integration significantly reduces distribution distance, time, and costs	Providing empirical evidence of the effectiveness of Lean-VRP integration in the supply chains of MSMEs
Gusta et al (2025)	Identifying waste in industrial hose distribution	PAM, VSM, Fishbone, 5W1H	The primary sources of waste are Waiting, Motion, and Transportation, with long lead times	Providing a framework for identifying waste and proposing lean-based improvements
Payungi (2022)	Optimization of product distribution routes	Nearest Neighbor and Tabu Search	The combination of heuristics and metaheuristics results in savings in both distance and time	Demonstrating the effectiveness of a combination of methods for finding optimal routes
Camellia et al (2025)	Analysis of Logistics Waste in Cable Manufacturing	Lean Logistics, Kaizen, PDCA, RCA	Seven types of waste were identified, caused by coordination issues and a semi-manual system	Providing a PDCA framework for continuous improvement in logistics waste
Amaral et al. (2022)	Improvements in Automotive Internal Logistics	PDCA, SIPOC, 5S, Visual Management	The implementation of lean tools reduces transportation waste and optimizes cycle time	Providing a practical PDCA-based milk run method
Proença et al (2022)	Optimizing the horticultural production flow	Lean Tools, VSM	Lean tools significantly reduce cycle time and lead time	Proving the effectiveness of lean in the perishable goods industry
Hasdi, Isharyani, and Wahyuda (2025)	Route Optimization for Srikandi Samarinda MSMEs	CWS, CFRS, Sweep, Nearest Neighbor	CFRS is more efficient than CWS in terms of distance and cost savings	Recommends CFRS as the optimal solution for MSMEs
Oktafianto and Arvitrida (2023)	Last-mile pickup and delivery optimization	Vehicel routing problem	A complex VRP model yields cost savings compared to the current situation	Developing a VRP model tailored to Indonesia's actual distribution operations
Rahman et al (2024)	Distribution Route Optimization for 3 Batik Outlets	VRP-GA, TSP-ACO, SPT	The three methods yield different performance results depending on the characteristics of the distribution	Provides a comprehensive comparison of three optimization approaches for MSMEs
Yudastio dan Refi Arioen (2024)	Technology and Lean for Distribution Efficiency	WMS, Route Planning, Pull System	The integration of technology and lean principles reduces lead time, costs, and inventory.	Provides evidence of effective lean technology integration.

3.5. Identification of Research Gaps and Implementation Challenges in MSMEs

Based on an analysis of ten journal articles, several research gaps were identified that still need to be addressed. First, most studies still apply Lean and VRP separately, while the integration of these two approaches into a single unified model remains rare, particularly in the context of Indonesian MSMEs. Second,

there is still a limited number of studies that take into account the specific characteristics of MSMEs, such as data limitations, minimal technological infrastructure, and high operational flexibility. Third, most studies are still simulation-based and have not been implemented in real-world settings, so model validation remains limited.

Identified implementation challenges include limited technological infrastructure, a lack of systematic historical data, the need for human resource training, and resistance to change among SME operators. These factors are important considerations when designing a model that is adaptive to the constraints faced by SMEs. A phased approach and the use of simple tools such as Microsoft Excel or the Google Maps API for distance calculations are highly recommended.

3.6. Implications for the Development of a Lean-VRP Integration Model

The synthesis of findings from the ten reviewed studies yields important implications across three distinct dimensions: managerial, methodological, and policy. These implications provide actionable guidance for MSME practitioners, researchers, and policymakers seeking to advance the adoption of integrated Lean-VRP approaches in the Indonesian MSME context.

From a managerial perspective, MSMEs should adopt a phased implementation approach, beginning with waste identification using tools such as Value Stream Mapping (VSM) before progressing to route optimization, as this gradual strategy reduces implementation risk and allows capabilities to be built incrementally. Tool selection should prioritize simple, low-cost solutions such as Excel templates for data recording, the Google Maps API for distance calculations, and open-source VRP solvers, which are accessible even with limited financial and technical resources. Operational integration between Lean and VRP is essential, as waste elimination efforts should directly inform route optimization by providing improved operational data and reduced inefficiencies. Change management is equally critical, requiring managers to involve operators from the outset, provide adequate training, communicate benefits clearly, and start with small pilot projects that demonstrate tangible results to build trust and overcome resistance. Finally, continuous improvement through PDCA (Plan-Do-Check-Act) cycles—including regular review meetings, consistent performance tracking, and incremental optimizations—is essential to sustain and build upon initial gains over time.

Methodological Implications**,** for researchers and academics, the most pressing methodological implication is the need for empirical validation of the proposed conceptual framework, as its practical effectiveness in real-world MSME settings remains unproven and requires case studies that implement the framework in actual operations while measuring tangible outcomes such as cost savings, time reductions, and operational improvements. Longitudinal studies are equally critical to assess the sustainability of Lean-VRP benefits over time, as most existing studies are cross-sectional and cannot confirm whether initial gains are maintained or eroded over extended periods. The use of mixed methods is strongly recommended, combining quantitative metrics—such as distance reduction, cost savings, and time improvements—with qualitative insights gained through interviews with MSME operators, observation of implementation processes, and analysis of organizational dynamics that influence successful adoption. Furthermore, sectoral diversity in MSME research should be expanded beyond the current concentration in manufacturing and distribution to include services, agriculture, and other MSME types, as operational characteristics, constraints, and opportunities vary significantly across sectors and require sector-specific guidelines for effective implementation.

Policy Implications, for policymakers and government agencies, the findings underscore the fundamental need for investment in digital infrastructure, as many Indonesian MSMEs lack the reliable Internet access, computers, and software required to implement even basic optimization tools, necessitating government support through subsidized hardware, public Internet access points, or cloud-based platforms. Training programs represent another critical intervention, as limited digital literacy and technical skills among MSME operators are consistently identified as implementation barriers, requiring practical, hands-on training on Lean principles, route optimization, and basic data management that is tailored to MSME constraints rather than generic or theoretical. Financial support mechanisms—such as subsidies, grants, or low-interest loans specifically targeted at MSME logistics digitalization—are essential to enable implementation, as broader adoption may require capital investment in technology, training, or consulting support. The development of a public platform for MSME route optimization would address a significant gap by providing free, accessible, user-friendly tools integrated with mapping services, dramatically lowering the barrier to adoption and

accelerating the diffusion of best practices. Finally, research funding for Lean-VRP integration studies should be prioritized, as the limited empirical validation of integrated approaches in the Indonesian MSME context constrains evidence-based policymaking, and government research grants, university-industry partnerships, and collaborative research programs would generate the empirical evidence needed to inform both practice and policy.

4. Conclusion

This study synthesizes literature from ten selected articles on Lean Logistics and VRP integration for reducing logistics costs in Indonesian MSMEs. The findings reveal that separate applications yield cost savings of 15–43%, yet integrated approaches remain rare due to data limitations, technological constraints, and limited digital literacy among MSMEs. The primary contribution is a conceptual four-stage Lean-VRP integration framework (waste identification via VSM, VRP modeling, simulation/validation, and PDCA-based continuous improvement) that explicitly distinguishes between sequential and simultaneous integration approaches. Unlike previous studies developed for large enterprises, this framework is tailored to MSME resource constraints and recommends low-cost, phased implementation using accessible tools such as Excel templates and Google Maps API. The findings have managerial implications for phased implementation, methodological implications for empirical validation needs, and policy implications for digital infrastructure support and training programs. However, several limitations must be acknowledged: the small sample of ten articles, limited database coverage, heterogeneity of studies, potential publication bias, and most importantly, the conceptual nature of the framework, which has not been empirically validated in real-world MSME settings—meaning practical claims should be treated with caution.

Future research should prioritize empirical validation through case studies in actual Indonesian MSMEs, longitudinal studies to assess sustainability, and sectoral diversity across services, agriculture, and creative industries. The development of specific mathematical formulations and simple decision support systems—such as mobile or cloud-based applications—would lower adoption barriers, while comparative studies between sequential and simultaneous models would strengthen model selection guidance. In conclusion, while the proposed framework is promising and grounded in systematic literature synthesis, it remains conceptual and requires empirical validation before strong practical claims can be made. By providing a structured, low-cost, phased approach tailored to resource-constrained MSMEs, this framework offers a practical starting point for improving logistics efficiency, ultimately contributing to enhanced competitiveness and economic development.

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