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Literature Review on Vehicle Routing Problem: Approaches, Algorithms and Current Challenges

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Abstract

The Vehicle Routing Problem (VRP) is one of the basic combinatorial optimization problems that takes a central place in the sphere of logistics, transportation, and supply-chain management. A systematic literature review (SLR) of VRP scholarship dated 2000 to 2025 is conducted herein, where over 500,000 publications are analyzed to carry out the study of VRP solutions evolution and methodological advancements as well as their practical use. The results highlight the current popularity of metaheuristic algorithms, such as Ant Colony Optimization (ACO), Genetic Algorithms (GA), and Particle Swarm Optimization (PSO), in solving complex variants of VRP, in particular, the Capacitated Vehicle Routing Problem (CVRP) and the Vehicle Routing Problem with Time Windows (VRPTW). The combination of real-time data streams, machine-learning methods and adaptive algorithms represents a revolutionary track, and helps to develop more active and responsive VRP models. Moreover, increased attention to sustainability and green logistics has triggered the development of the eco-efficient VRP models, which combine the use of electric vehicles (EVs) and energy-consumption optimization. The spread of autonomous vehicles presents new opportunities and threats to future VRP solutions, particularly in the area of urban freight and last-mile delivery. In conclusion, the review outlines future streams of research, highlighting the need to find adaptive, sustainable, and autonomous VRP models that can resolve the growing complexities in the modern world of logistics.

Introduction

The first researcher to introduce the concept of *Truck Dispatching Problem* (Dantzig & Ramser 1959), which is a mathematical modeling to determine the optimal route of a homogeneous truck fleet in distributing products (eg fuel) from a central terminal to a number of filling stations with predetermined demand, so that the total distance traveled by the entire fleet can be minimized. Five years after Dantzig and Ramser's research, (Clarke & Wright 1964) developed a new approach in scheduling a truck fleet with varying capacities departing from a central depot to serve a number of delivery points.

By considering the capacity and distance aspects, they proposed an efficient iterative procedure that can be used both manually and with the help of a digital computer. This approach is a significant initial step in the generalization of distribution problems into *Vehicle Routing Problem* (VRP), which is how to serve a group of geographically dispersed customers with a minimum route using a limited fleet of vehicles. Since then, VRP has become one of

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the most widely researched topics in the fields of *Operations Research*, logistics, and transportation. However, the VRP model.

Researchers Lenstra & Kan (1981), Exact algorithms are generally only efficient for solving small-scale problems. In practice, heuristic and metaheuristic approaches are more often used because they are more suitable for handling large-scale and complex real-world problems. For example, a company may be faced with the need to serve thousands of customers from dozens of depots, using various types of vehicles, and must meet various operational constraints. Samsuddin et al. (2018) Over time, various solution methods for VRP variants introduced in academic literature both classical and modern have grown rapidly in recent decades. This development is driven not only by practical needs, but also by the very significant increase in computer processing speed and memory capacity. Advances in computing technology make it possible to solve large-scale VRP cases that previously could not be solved efficiently.

As a result, research and development in the VRP field continues to progress, including the development of commercial software specifically designed to handle various VRP variants effectively and efficiently. Today it is very different where it increasingly aims to include real-life complexities, such as time-dependent travel times (traffic congestion), window times for pickup and delivery, and input of dynamically changing information (demand). Currently VRP software is used by thousands of companies including: Coca-Cola Enterprises and Anheuser-Busch Inbev in various industrial sectors (Drexl 2013).

Vehicle Routing Problem (VRP) is a fundamental and complex optimization challenge that has garnered significant attention in logistics, supply chain management, and operational research. It involves designing optimal delivery or collection routes for a fleet of vehicles to serve a geographically dispersed set of customers, while minimizing transportation costs and adhering to various constraints. VRP is not only a critical component of efficient transportation management but also a cornerstone of modern logistics systems, impacting industries such as e-commerce, waste collection, and public transportation (Hamdi-Dhaoui et al., 2011).

Methods

The systematic literature review (SLR) in this study focuses on clustering city division based on geographical location and vehicle capacity and then computing with ACO using MATLAB software: searching from databases such as Google Scholar, Science Direct, etc., with the keywords "Systematic literature review" and "lean manufacturing", will not find any articles about it. The objectives of this lean review study are as follows: (1) What is the role of *Nearest Neighbor in* clustering city division (2) How to design Vehicle Routing Problem With Pick Up And Delivery using ACO? SLR was conducted to achieve the objectives of this study. SLR differs from traditional desk reviews by its scientific, transparent, and replicable process to minimize bias through in-depth literature searches, providing an audit trail and applying explicit and reproducible methods to examine relevant studies and achieve comprehensive accuracy while reducing bias (Saleh et al., 2023; Moher et al., 2009). This methodology allows researchers to clearly articulate the inclusion and exclusion criteria of studies, thus providing a more transparent explanation of the methodology used (Khairuddin & Mohamed, 2023). This method is presented and aligned with many high-quality scientific journals such as (Braekers et al., 2016; Sar & Ghadimi, 2023). The flowchart of the SLR method can be seen in Figure 1.1.

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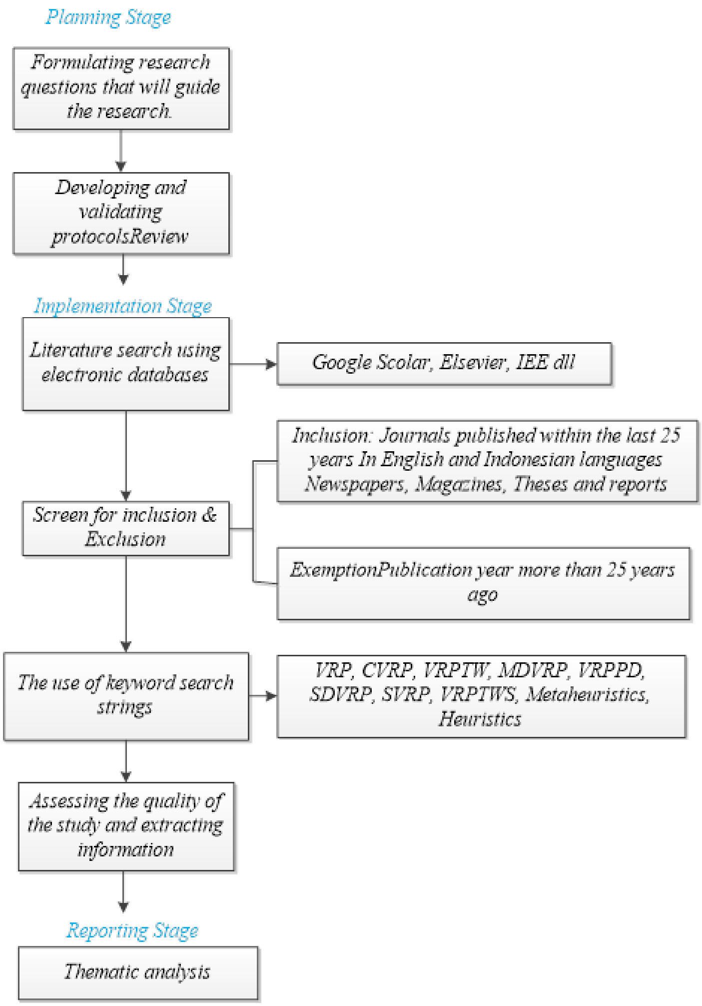

Figure 1. Stages of SLR Research

In the planning stage, the first step of the SLR stage is to formulate a research question that will guide the research. At this stage, the literature review focuses on the research question, which is the main guide in the entire literature review process. The selection of studies and data analysis to formulate results aims to answer the research question. However, novice researchers often make the mistake of choosing a research question that is too broad (Michael Coughlan et al., 2008). Questions that are too broad make the literature review unfocused because there is too much data to analyze. Questions such as the trend of using Ant Colony Optimization in the case of vehicle routing problems are the basis of this entire literature review process.

Then, a review protocol was developed and validated. A review protocol is essential for a transparent, systematic, and replicable ongoing literature review (Okoli & Schabram, 2012). A review protocol is conducted by defining the research objectives, research questions, inclusion and exclusion criteria, screening procedures, and reporting (Gates 2002)(Gomersall et al. 2015). Before a review protocol is implemented, it must be thoroughly validated. In this study, the protocol was validated by supervisors and peers. Since literature reviews develop knowledge, it is important to carefully evaluate and critique the protocol to improve the quality of research (Xiao, Y., & Watson 2019).

The next stage is the conductor stage. At this stage, we started by searching for literature using electronic databases. Electronic databases are the main source for collecting published literature [70]. Since no single database covers all available materials, literature searches were

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conducted in several databases. Some of the electronic databases used in this study are Google Scholar, Taylor & Francis, Elsevier, IEEE and Emerald. In this study, only English-language literature with a publication year of no more than 25 years was used. In addition, "gray literature" such as newspapers, news, theses and reports were not included in this study.

The literature search focused on "Vehicle Routing Problem" AND " Ant Colony Optimization ".Then combine it with various keywords such as " Vehicle Routing Problem " AND " Capacited Vehicle Routing Problem ", " Nearest Neighbor " AND " Ant Colony Optimization " (Prabowo, Imran, and Prassetiyo 2023); (Setyati and Juniwati 2022); (Mulyani and Aryanny 2024). This study does not include articles that use Ant Colony Optimization outside. Researchers ensure that there is no significant human error in choosing terms, databases, periods, or other relevant factors. Next, we assess the quality of the studies and extract information from the articles found. The quality of these studies is assessed based on their index and relevance by reviewing the abstract. Abstract review is conducted to determine the focus of each study and identify the purpose of designing a vehicle routing problem with pickup and delivery (Setyati and Juniwati 2022); (Zafra and Gibaja 2023); (Martono, Leslie, and Spits 2020); (Maryati and Wibowo 2012); (Koswara, 2018) (Prasetyo & Tamyiz, 2017); (Adhitama, 2020). The last stage is the reporting stage. In this stage, thematic analysis is carried out by extracting themes that emerge from the literature, grouping them and finally synthesizing them into more structured analytical themes.

Results and Discussion

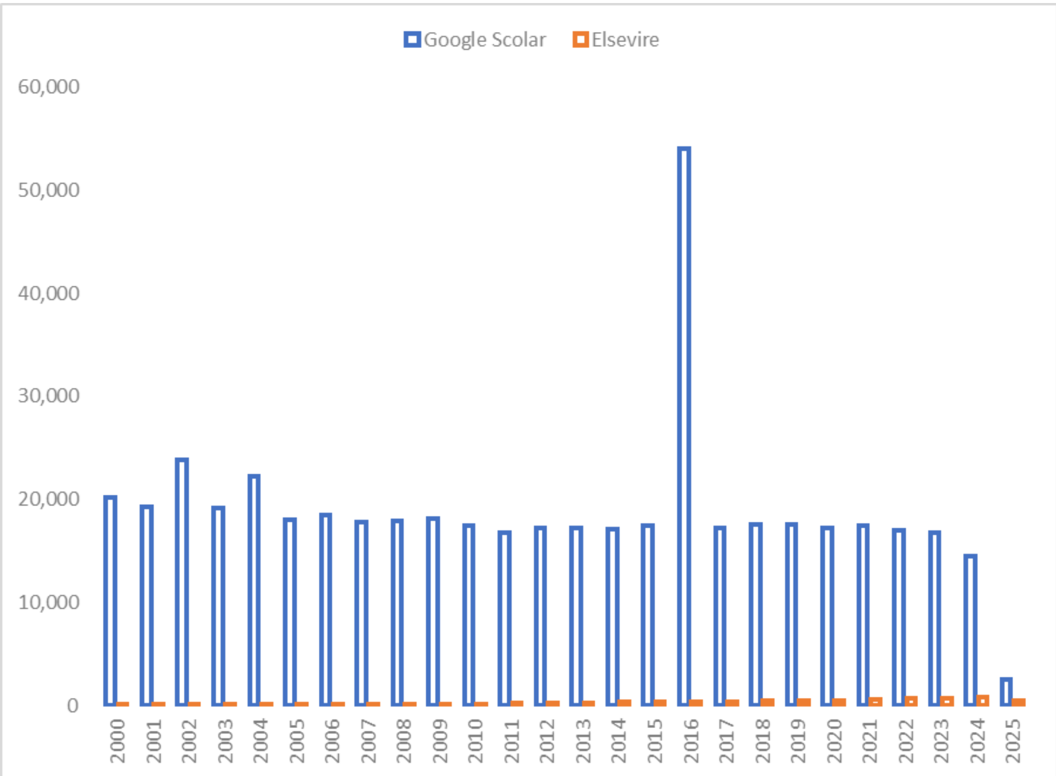

Figure 2. Number of Papers and Corresponding Number of Citations from 2000 to 2025

The systematic literature review (SLR) of the vehicle routing problem (VRP) revealed a considerably large, and also fast-growing amount of scholarly literature, thus, highlighting the enhanced relevance of the considered issue in the real-world logistics and operations research spheres. The review undertook an extensive search on two major repositories, viz.

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Google Scholar and Elsevier, that resulted in the retrieval of 489, 960 records and 7 489 records respectively. The high magnitude of such discrepancy could be explained by the wider scope offered by Google Scholar which integrates a non-homogenous collection of scholarly products, encompassing non-peer-reviewed products, as compared to the repository offered by Elsevier which is limited to rigorous peer-reviewed materials. However, despite these differences in breadth, both sources of data that prove the existence of a significant, sustained interest in the study of VRP over the 2000-2025 years, with strong foci points that depict an even stronger emphasis on the state of art of the research of optimization strategies of logistics systems.

The Surge of Interest in VRP: A Temporal Analysis

Figure 2 demonstrates that the peak in the number of publications on VRP in Google Scholar was in 2016, and more than 50,000 papers were published. This is the trend in the face of heightened scholarly and business interest in addressing the logistics issues in an ever-expanding global economy, particularly in the logistics, e-commerce, and delivery domains. It is worth noting that the year 2016 was a pivot point at which researchers and companies started paying more and more attention to more advanced algorithms and computational methods, including metaheuristics and machine learning, to address the increased complexity of VRP.

Elsevier, conversely, had its highest number of publications in 2023, but it had significantly fewer articles. Such a reduced figure can be explained by the peer-reviewed character of Elsevier database since only the high-quality and validated research is presented. Nevertheless, the frequency of publication by Elsevier indicates the stability of the high-quality academic input into the VRP domain, specifically in terms of more sophisticated and advanced approaches such as metaheuristics, adaptive algorithms, and the use of real-time data.

Table 1: Summary of VRP Models and Their Real-World Applications

VRP Model	Main Objective	Key Challenges	Approaches & Algorithms	Applications
Capacitated VRP (CVRP)	Minimize total travel distance considering vehicle capacity	Ensuring all customer demands are met within vehicle limits	ACO, GA, Tabu Search, Simulated Annealing	Optimizing fleet usage for delivery of goods
VRP with Time Windows (VRPTW)	Minimize travel time while adhering to time window constraints	Balancing delivery speed with customer satisfaction	ACO, PSO, Genetic Algorithms	Time-sensitive deliveries such as medical supplies or food
Multi-Depot VRP (MDVRP)	Optimize routes across multiple depots	Managing multiple depots while minimizing travel costs	Genetic Algorithms, Simulated Annealing	Multi-location distribution systems like logistics hubs
Split Delivery VRP (SDVRP)	Allow multiple visits to serve a customer	Managing excess demand that exceeds vehicle capacity	Tabu Search, ACO, GA	Courier services with flexible delivery schedules

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Stochastic VRP (SVRP)	Optimize routes in uncertain environments	Dealing with random fluctuations in customer requests or service time	Markov Decision Process, Stochastic Programming	Routes with uncertain demand, such as emergency services
Periodic VRP (PVRP)	Schedule deliveries over multiple periods	Handling varying service frequencies for each customer	Hybrid Genetic Algorithms, Dynamic Programming	Scheduled deliveries (e.g., weekly or monthly cycles)

The table above gives a brief overview of the variants of the Vehicle Routing Problem (VRP) that have been studied most widely and the real-world applications of the variants. As it has been shown, the Capacitated Vehicle Routing Problem (CVRP) and the Vehicle Routing Problem with Time Windows (VRPTW) are two of the most studied VRP models, which is partially explained by the fact that they are the most commonly applied to such industries as freight distribution and e-commerce logistics. CVRP is concerned with an efficient distribution of a fleet of vehicles to meet the demand of customers with minimum costs, when VRPTW takes into account time constraints to enhance the quality of services and client satisfaction. More variants are appearing as the logistics operations continue to become more complex: Multi-Depot Vehicle Routing Problem (MDVRP) and Split Delivery Vehicle Routing Problem (SDVRP) are two examples that have been identified to resolve particular issues relating to managing multiple distribution centres and demand that surpasses the carrying capacity of individual vehicles.

Table 2: Algorithm Performance and Solution Quality Across VRP Models

VRP Model	Algorithms Used	Computational Time	Solution Quality	Key Advantages
Capacitated VRP (CVRP)	ACO, GA, Simulated Annealing	Medium to High	Close to optimal in most cases	Efficient in solving large-scale distribution problems
VRP with Time Windows (VRPTW)	ACO, PSO, Genetic Algorithms	High	Optimal in many situations	Balances tight delivery schedules and customer satisfaction
Multi-Depot VRP (MDVRP)	Genetic Algorithms, Simulated Annealing	Medium to High	Approaches optimal solutions	Handles multiple depots, reducing operational costs
Split Delivery VRP (SDVRP)	ACO, Tabu Search, Genetic Algorithms	Medium	Efficient in handling large demand	Enables flexible deliveries with multiple visits
Stochastic VRP (SVRP)	Markov Decision Process, Stochastic Programming	High	Varied due to uncertainty	Addresses uncertainty in service times and demand fluctuations

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Periodic VRP (PVRP)	Hybrid Genetic Algorithms, Dynamic Programming	Medium	Optimal for periodic services	Useful for scheduled deliveries, optimizing vehicle capacity and time

Table 2 results suggest the quality of computational performance and solution of different algorithms when used to solve several vehicle routing problem (VRP) model. Particularly effective demonstrations of meta-heuristics algorithms on the capacitated VRP (CVRP) and the VRP with time windows (VRPTW) are the Ant Colony Optimization framework, Genetic Algorithms, and Simulated Annealing, which in many cases produce solutions that are within a reasonable time frame of optimum performance. In turn, the models that use more complex constraints, i.e., the Stochastic VRP (SVRP), and the Periodic VRP (PVRP), require more computation. The two models are specifically made to handle uncertainty and time-related constraints, respectively, and by nature, make the process of finding a solution more complex.

The Vehicle Routing Problem, which is discussed in this systematic literature review, remains dynamic and presupposes gaining even more importance with the development of logistics and transportation systems. The radical increase in the number of academic publications, especially in 2016-2023, highlights the growing academic interest in streamlining logistical procedures with the help of state-of-the-art computational tools. The robustness of meta-heuristic techniques such as the Ant Colony Optimization, Genetic Algorithms and Particle Swarm Optimization can be seen in the variation of VRP studied. They have made these algorithms a primary focus of solving the problems that are combinatorical in nature of the VRP allowing researchers and practitioners to approach previously considered computationally intractable problems.

The Role of Metaheuristics in VRP Solution Strategies

Metaheuristic methods represent one of the foundations of the study of the problem of the vehicle routing (VRP) and it can be explained by the fact that these issues are characterized by the complex nature of both the data sets and the number of operational constraints. Of these methods, the Ant Colony Optimization (ACO) algorithm has proved to be one of the most effective methods of solving Capacitated VRP (CVRP) and Vehicle Routing Problem with Time Windows (VRPTW). ACO is inspired by the communication that can be found in the ant colonies where pheromones are used to locate the shortest possible routes between the nest and food sources of the ants. This can be applied to the VRP and allows the algorithm to explore the search space methodically and find the best solutions by reinforcing the promising routes through the application of simulated pheromone trails. The technique is especially beneficial to CVRP, in which it directly trades off the overall travel distance with vehicle capacity limitations (Zhang et al., 2022; Salehi Sarbijan & Behnamian, 2023; Eltoukhy et al., 2025).

COP is commonly used in VRP; nevertheless, Genetic Algorithms (GA) have also had a great impact on the field, particularly with respect to more challenging variations like Multi-Depot VRP (MDVRP). The flexibility of the nature of GA enables it to pursue various goals: the minimisation of the travel distance, operation cost upper limit, and workloads allocation among various depots at the same time (Tafakkori et al., 2025; Chen et al., 2024; Alamatsaz et al., 2022).. Through imitation of natural selection, GA produces candidate solutions by using crossover, mutation and selection operators. It is particularly useful in situations when multiple depots are involved and they are required to coordinate their deliveries without

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compromising the optimality in a range of constraints and operational imperatives. Evolutionary character of GA is such that the range of possible solutions is searched, which contributes to further optimization and the ability to meet logistics challenges that are becoming more and more challenging (Alolaiwy et al., 2023).

However, with more and more complex and dynamic environments that the logistics sector faces to deal with, the constraints of classic metaheuristic techniques in real-time problem solving are becoming apparent. As a result, the need to explore new methods, such as machine learning solutions and real-time data aggregation, to respond to the dynamic nature of VRP problems, is increasing.

Technological Advancements: Real-Time Data Integration and Machine Learning

Another trend that is notable in literature about the vehicle routing problem (VRP) is the integration of real-time information streams and modern machine-learning practices. The traditional VRP models are often based on the assumption that the journey is fixed, that the demand of customers is deterministic, and so the models are limited in their application in the highly dynamic real world. The recent development of big-data analytics and Internet of Things (IoT) systems has made the unceasing entry of live data into VRP models possible and thus made it possible to recalibrate routes to current conditions. This dynamic VRP (DVRP) movement forms a strong contrast to the traditional methods which provide a single optimal route and hold on to that route despite the following disruptions (Zhang et al., 2022; Mardešić et al., 2023).

Machine-learning algorithms have proven to transform the e-commerce logistics and urban freight systems. To illustrate, Amazon uses predictive models that predict the demand trends, as well as to optimize delivery schedules based on historical data. Such systems are in a process of constant education and correction and improve predictive accuracy of estimated delivery times and reveal route optimisation possibilities. The subfield of machine learning called reinforcement learning has become especially promising as it allows VRP platforms to optimise not only according to the past experiences but also to incorporate the real-time feedback. These systems are able to adapt to the dynamics of traffic jams, weather conditions, and last-minute shipment orders using such dynamic capabilities, which are essential to the modern logistics when time and efficiency of operation play the most crucial role.

Besides, the combination of cloud-computing architectures will enable combining vast amounts of data that are generated by very dissimilar sensors including traffic detectors, GPS receivers, and so on, thus making the VRP models more adaptable and more responsive. The ability to conduct real-time integrations of dissimilar data represents an important methodological development that breaks the shackles of VRP and moves the concept of intelligent logistics networks hoped to be developed in the future.

Green Logistics: Sustainability in VRP Optimization

The growing need of environmental sustainability creates new challenges in the logistics industry, especially in the process of embedding of green logistics concepts in the vehicle routing approach (VRP) optimization module. The traditional VRP models tend to focus on temporal, spatial and monetary goals, but this particular narrowness does not suit the international movement towards sustainability. Accordingly, the ecological implications of logistics activities such as CO_2 emissions and energy usage have been central contributors to defining the modern VRP studies (Marrekchi et al., 2021).

The proportion of electric vehicles (EVs) in green logistics projects is increasing, but it also poses new challenges to VRP optimisation. However, in contrast to traditional internal-

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combustion car models, EVs require that special attention be paid to the use of energy, the duration of the battery, and the availability of charging stations when planning a route. The existing EV-based VRP models are still in a primitive stage although they are gradually being embraced as tools of reducing the carbon footprints of logistics. This class of models incorporates charging station localisation and energy-efficient routing as auxiliary conditions, and is thus cost- and environment-optimal. In addition, the increasing use of environmentally friendly cars forces the implementation of carbon emission limits and energy consumption limits into the VRP solution approach. This new focus on sustainable VRP is aimed at assuring that the logistics networks reduce environmental impact without reducing operational efficiency or service level (Gouraji et al., 2025; Moghaddasi et al., 2023).

Future studies on green VRP models should build on the EV route optimisation by considering the use of renewable energy and the sustainability of logistic networks in general. With these tenets, the logistics sector can serve a greater effort to curb climate change and at the same time in improving its operational efficiencies.

Autonomous Vehicles and Future VRP Developments

The advent of autonomous vehicles is a promising future of vehicle routing problem (VRP) optimization. The self-driving trucks, drones, and robot delivery vehicles have the potential to reshape the logistics industry radically since the working hours and exhaustion of the human factor would no longer be a limitation. However, integrating autonomous vehicles into the system of VRPs prompts numerous new issues, the main one being related to coordination and fleet control. Autonomous vehicles will have to move smoothly in packing unlike in case of the traditional models where human drivers are involved and are expected to exchange information as well as maneuver routes dynamically (Chen et al., 2023).

This technological change helps to emphasize the need to develop autonomous VRP (AVRP) models that would allow self-driving fleets to communicate and cooperate in real-time and improve routes to reduce the time of trips and operational expenses. The swarm intelligence and multi-agent systems (MAS) provide promising paradigms to model the coordination of autonomous vehicles; these systems assist in sharing the information on the route and modifying it adaptively to the current real-life situation. The main difficulty is to make such vehicles work safely and efficiently in complex and real-life conditions, especially in big cities where there are obstacles, such as traffic, people, and weather conditions, that pose a great danger.

The study of AVRP models opens up the opportunities to provide solutions to last-mile delivery in urban settings where traditional vehicle fleets are faced with congestion and tight deadline requirements (Moradi et al., 2024). With the further development of autonomous vehicle technologies, their application to solve VRP is a prospect to transform the logistics to a more efficient, cost-effective, and flexible form.

Conclusion

Vehicle Routing Problem (VRP) is a classical issue in the optimisation of logistics, which is deeply rooted in the theoretical research into the operational effectiveness and transportation management. This review shows that the issue has been changing throughout the years, and metaheuristic algorithms like the Ant Colony Optimization (ACO), Genetic Algorithms (GA), and Particle Swarm Optimization (PSO) have become a focal point of various VRP variants problems. They have been critical in offering solutions to these types of logistics problems such as Capacitated VRP (CVRP) and the VRP with Time Window (VRPTW), as they have minimised the cost of travelling and optimised the fleet.

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With the development of technology, real-time information and machine-learn algorithms are being incorporated into modern VRP solutions, which marks the transition of a fixed optimisation to a dynamic and adaptive system. Traffic, weather and customer information are now available in real-time, allowing on-the-fly route modifications to enhance efficiency and customer satisfaction. Amazon and DHL are among the firms that have been able to introduce machine-learned VRP models and this example shows that AI-oriented logistics are possible that can be adjusted and changed over time. This trend is the future of VRP, in which the data-driven insights keep improving the optimisation.

As the importance of sustainability is increasing, a sharp move is observed towards the integration of green logistics with VRP optimisation. The electric vehicle (EV) growth has inspired the creation of eco-friendly VRP models by optimizing the time and cost factors, as well as the energy use and carbon emission. This is an indication of a larger trend in the field of logistics to decrease negative effects on the environment and yet achieve the same operational efficiency, which highlights why the future studies on VRP need to take not only environmental goals but also economic ones.

In the future, the emergence of autonomous vehicles offers new prospects in the form of VRP optimisation. Drones and self-driving trucks will transform last-mile delivery and fleet management, but they present new challenges of coordination and integration of the vehicle. Future VRP studies must consider the incorporation of autonomous systems into logistics networks in a way that they can be seamlessly incorporated, thus producing smoother, flexible, as well as more affordable solutions. Because VRP is still in development, it is an important question worth studying, as it determines the future of the global logistics systems.

Suggestion

This study confirms that the choice of algorithm is highly dependent on the context and specifics of the problem at hand. In the future, research can be directed at combining adaptive approaches based on actual operational data and environmental sustainability aspects. The next important question that needs to be answered is: how to develop a VRP system that is not only optimal, but also flexible in facing the dynamics of modern logistics? Further research can expand the scope to the integration of real-time strategic and operational decision-making systems in complex and uncertain distribution environments.

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References

Adhitama, L. (2020). *Development of Ant Colony Optimization Algorithm to Improve Distribution Routes in Green Capacited Vehicle Routing Problem (GCVRP)*. *2507* (February), 1–9.

Alamatsaz, K., Ahmadi, A., & Mirzapour Al-e-hashem, S. M. J. (2022). A multiobjective model for the green capacitated location-routing problem considering drivers' satisfaction and time window with uncertain demand. *Environmental Science and Pollution Research*, *29*(4), 5052-5071. https://doi.org/10.1007/s11356-021-15907-x

Alolaiwy, M., Hawsawi, T., Zohdy, M., Kaur, A., & Louis, S. (2023). Multi-objective routing optimization in electric and flying vehicles: a genetic algorithm perspective. *Applied Sciences*, *13*(18), 10427. https://doi.org/10.3390/app131810427

Cari, T., Gali, A., Fosin, J., Gold, H., & Reinholz, A. (2008). A Modeling and Optimization Framework for Real-World Vehicle Routing Problems. *Vehicle Routing Problems* , *September.* https://doi.org/10.5772/5790

Chen, L., Li, Y., Huang, C., Xing, Y., Tian, D., Li, L., ... & Wang, F. Y. (2023). Milestones in autonomous driving and intelligent vehicles—Part I: Control, computing system design, communication, HD map, testing, and human behaviors. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, *53*(9), 5831-5847. https://doi.org/10.1109/TSMC.2023.3276218

Chen, W., Men, Y., Fuster, N., Osorio, C., & Juan, A. A. (2024). Artificial intelligence in logistics optimization with sustainable criteria: A review. *Sustainability*, *16*(21), 9145. https://doi.org/10.3390/su16219145

Clarke, G., & Wright, J. W. (1964). Scheduling of Vehicles from a Central Depot to a Number of Delivery Points. *Operations Research* , *12* (4), 568–581. https://doi.org/10.1287/opre.12.4.568

Dantzig, G. B., & Ramser, J. H. (1959). The Truck Dispatching Problem. *Management Science* , *6* (1), 80–91. https://doi.org/10.1287/mnsc.6.1.80

Drexl, M. (2013). Applications of the vehicle routing problem with trailers and transshipments. *European Journal of Operational Research* , *227* (2), 275–283. https://doi.org/https://doi.org/10.1016/j.ejor.2012.12.015

Eltoukhy, A. E., Hashim, H. A., Hussein, M., Khan, W. A., & Zayed, T. (2025). Sustainable vehicle route planning under uncertainty for modular integrated construction: multi-trip time-dependent VRP with time windows and data analytics. *Annals of Operations Research*, 1-36. https://doi.org/10.1007/s10479-024-06442-2

Francis, P., Smilowitz, K., & Tzur, M. (2007). Flexibility and complexity in periodic distribution problems. *Naval Research Logistics* , *54* (2), 136–150. https://doi.org/10.1002/nav.20195

Fu, B., Smith, W., Rizzo, D., Castanier, M., & Barton, K. (2020). Heterogeneous vehicle routing and teaming with Gaussian distributed energy uncertainty. *IEEE International Conference on Intelligent Robots and Systems* , 4315–4322. https://doi.org/10.1109/IROS45743.2020.9341433

Gates, S. (2002). Review of methodology of quantitative reviews using meta-analysis in ecology. *Journal of Animal Ecology* , *71* (4), 547–557. https://doi.org/10.1046/j.1365-2656.2002.00634.x

Gomersall, J.S., Jadotte, Y.T., Xue, Y., Lockwood, S., Riddle, D., & Preda, A. (2015). Conducting systematic reviews of economic evaluations. *International Journal of Evidence-Based Healthcare* , *13* (3), 170–178. https://doi.org/10.1097/XEB.0000000000000063

Gouraji, R. E., Soleimani, H., & Najafi, B. A. (2025). Optimization of Sustainable Vehicle Routing Problem Taking into Account Social Utility and Employing a Strategy with Multiple Objectives. *Int. J. Eng. Trans. B Appl*, *38*, 1631-1658.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Hamdi-Dhaoui, K., Labadie, N., & Yalaoui, A. (2011). The vehicle routing problem with conflicts. *IFAC Proceedings Volumes (IFAC-PapersOnline)* , *44* (1 PART 1), 9799–9804. https://doi.org/10.3182/20110828-6-IT-1002.01565

Koswara, H. (2018). Determination of T-Shirt Product Distribution Route at Dobujack Inv. Using the Nearest Neighbor Method and (1-0) Insertion Intra Route. *Jurnal Rekayasa Sistem & Industri (JRSI)* , *4* (02), 192–198. https://doi.org/10.25124/jrsi.v4i02.286

Mardešić, N., Erdelić, T., Carić, T., & Đurasević, M. (2023). Review of stochastic dynamic vehicle routing in the evolving urban logistics environment. *Mathematics*, *12*(1), 28. https://doi.org/10.3390/math12010028

Marrekchi, E., Besbes, W., Dhouib, D., & Demir, E. (2021). A review of recent advances in the operations research literature on the green routing problem and its variants. *Annals of Operations Research*, *304*(1), 529-574. https://doi.org/10.1007/s10479-021-04046-8

Martono, S., Leslie, H., & Spits, H. (2020). *Determining the Delivery Route of Goods Using the Nearest Neighbor Method. 13* (1), 44–57.

Maryati, I., & Wibowo, HK (2012). *Optimization of vehicle route determination in goods distribution system with ant colony optimization 1.* 2012 *(* Semantics), 163–168.

Michael Coughlan, Patricia Cronin, & Frances Ryan. (2008). Undertaking a literature review: a step-by-step approach What is a literature review? *38 British Journal of Nursing* , *17* (1), 39–43.

Moghaddasi, B., Majid, A. S. G., Mohammadnazari, Z., Aghsami, A., & Rabbani, M. (2023). A green routing-location problem in a cold chain logistics network design within the Balanced Score Card pillars in fuzzy environment. *Journal of Combinatorial optimization*, *45*(5), 129. https://doi.org/10.1007/s10878-023-01056-z

Mohamed, MK and M. (2023). Systematic Literature Review on Graduates' Social Intelligence. *J. Techno-Social* , *15* , 69–77. doi: 10.30880/jts.2023.15.01.006

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ (Online)* , *339* (7716), 332–336. https://doi.org/10.1136/bmj.b2535

Mor, A., & Speranza, M. G. (2022). Vehicle routing problems over time: a survey. *Annals of Operations Research* , *314* (1), 255–275. https://doi.org/10.1007/s10479-021-04488-0

Moradi, N., Wang, C., & Mafakheri, F. (2024). Urban air mobility for last-mile transportation: A review. *Vehicles*, *6*(3), 1383-1414. https://doi.org/10.3390/vehicles6030066

Mulyani, MR, & Aryanny, E. (2024). Minimizing Nail Distribution Routes Using the Ant Colony Optimization Method With MATLAB. *Journal La Multiapp* , *5* (3), 176–186. https://doi.org/10.37899/journallamultiapp.v5i3.1311

Okoli, C., & Schabram, K. (2012). A Guide to Conducting a Systematic Literature Review of Information Systems Research. *SSRN Electronic Journal* , *10* (2010). https://doi.org/10.2139/ssrn.1954824

Prabowo, F., Imran, A., & Prassetiyo, H. (2023). Determining Distribution Routes Using Savings Matrix, Nearest Neighbor, and 2-Opt Methods on CV X. *Journal of*

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Industrial Engineering Optimization (JOTI) , *5* (2), 47. https://doi.org/10.30998/joti.v5i2.15620

Prasetyo, W., & Tamyiz, M. (2017). Vehicle Routing Problem Using the Nearest Neihbor Method Application. *Route Construction and Local Search Algorithms Inform. Systems Operations Research* , *3* (2), 39:104-118.

Saleh, C., Hidayati, F., & Ar Rasyid, NH (2023). *Public Human Resources Development Systematic Literature Review.* Atlantis Press SARL. https://doi.org/10.2991/978-2-38476-082-4_24

Salehi Sarbijan, M., & Behnamian, J. (2023). Emerging research fields in vehicle routing problem: a short review. *Archives of Computational Methods in Engineering*, *30*(4), 2473-2491. https://doi.org/10.1007/s11831-022-09874-w

Samsuddin, S., Othman, MS, & Yusuf, LM (2023). *A REVIEW OF SINGLE AND POPULATION-BASED METAHEURISTIC ALGORITHMS SOLVING MULTI DEPOT VEHICLE ROUTING PROBLEMS. 4* (2), 17–23.

Sar, K., & Ghadimi, P. (2023). A systematic literature review of the vehicle routing problem in reverse logistics operations. *Computers and Industrial Engineering* , *177* (January 2022), 109011. https://doi.org/10.1016/j.cie.2023.109011

Setyati, E., & Juniwati, I. (2022). Ant Colony Optimization Ant Colony Optimization to solve Snack distribution routing with Vehicle Routing Problem. *Journal of Information and Applied Technology* , *9* (2), 111–117. https://doi.org/10.25047/jtit.v9i2.296

Tafakkori, K., Tavakkoli-Moghaddam, R., & Siadat, A. (2025). Scheduling multi-configuration last-mile delivery logistics by learning from optimisation feedback and customer preferences. *International Journal of Production Research*, 1-30. https://doi.org/10.1080/00207543.2025.2507795

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. Journal of planning education and research. *Journal of Planning Education and Research* , 93-112.

Zafra, A., & Gibaja, E. (2023). Nearest neighbor-based approaches for multi-instance multi-label classification. *Expert Systems with Applications* , *232* (June), 120876. https://doi.org/10.1016/j.eswa.2023.120876

Zhang, H., Ge, H., Yang, J., & Tong, Y. (2022). Review of vehicle routing problems: Models, classification and solving algorithms. *Archives of Computational Methods in Engineering*, *29*(1), 195-221. https://doi.org/10.1007/s11831-021-09574-x

Zhang, H., Ge, H., Yang, J., & Tong, Y. (2022). Review of vehicle routing problems: Models, classification and solving algorithms. *Archives of Computational Methods in Engineering*, *29*(1), 195-221. https://doi.org/10.1007/s11831-021-09574-x

ISSN: 2716-3865 (Print), 2721-1290 (Online)