Analysis of Recency in the Evolution of Routing Problems: A Literature Review of VRPPD, CVRP, and VRPTW

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Abstract. A strategic step in strengthening the business ecosystem in the digital era is by improving the efficiency of the supply chain. One of the efficiency discussions is about vehicle routing problems with simultaneous pickup and delivery and time window constrains. This research aims to provide a thorough analysis of foremost challenges and issues in solution methods using algorithm as well as research trends, for effective problem solving related to VRPPD, CVRP, and VRPTW. To achieve these objectives, research with reference to the PRISMA guidelines has been conducted to set research questions and objectives, to conduct data extraction and to analyze relevant literatures from the last ten-year period (2014-2024). The focus of the analysis covered three main variations of VRP (VRPPD, CVRP, and VRPTW) using the PRISMA and resulted in 25 article reviews. The finding was that about 44% of the algorithms in the reviews were Hybrid methods, the ones that combine two or more algorithms. In addition, they were more hybrid compared to heuristic, exact and others.

Keywords: Analysis, Routing Problems, Literature Review, VRPPD, CVRP, VRPTW.

1 Introduction

VRP, as a routing problem, has come into use for managing logistics and distribution world-wide [1]. It has become a vital role because its main objective is to design a delivery route with minimal cost. Through a number of geographically dispersed customers, a graph theory was implemented and it took into account various existing constraints [2]. In fact, VRP has become a major focus in academic research and industrial applications due to its great relevance to the real world.

VRP exists with some fundamental elements, such as the existence of depots, the quantity of customers, the distance between depots and customers, the number of vehicles with a certain capacity, and the travel time between locations [3]. Over the past three decades, advances in computing and computer accessibility have brought significant progress in the development of algorithms that can handle VRP [4]. VRP research

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began in the mid-20th century and has evolved since then into various variants with specific purpose. The variants are Vehicle Routing Problem with Pickup and Delivery (VRPPD), Capacitated Vehicle Routing Problem (CRVP), and Vehicle Routing Problem with Time Window (VRPTW). They are specially designed to meet the logistics and distribution needs, as mentioned in their names, for their customers [5].

This research is growing rapidly around the world, especially in the countries with developed logistics sectors, such as in the United States, Europe, and Asia. The improvement of the vehicle routing efficiency has been driven by rapid developments in supply chain management theory and practice [6]. As a result, VRP literature has grown rapidly in response to this challenge. Recent approaches have not only led to operational efficiency of logistics and distribution, but also have reduced cost and environmental impacts. This research intends to present a systematic literature review of VRPPD, CVRP and RPTW researches over the past ten years to provide a comprehensive understanding of the developments and the future research directions [7]. It mainly focuses on developing a taxonomic framework that enables the identification of gaps in the literature and to highlight potential research topics. The review will include an analysis of the methods used, the results achieved, and the scope of VRPPD, CVRP and VRPTW context approaches.

An analysis method, Preferred Reporting Items for Systematic Reviews and Meta-Analyses) or PRISMA, was utilized to identify and screen relevant studies comprehensively and systematically. This literature review will provide deep insights into a leading-edge of the three variants of VRP researches helping researches and practitioners apply the latest and the most effective foundation in facing the complex challenges in VRPPD, CVRP and VRPTW.

2 Research Methods

A systematic literature review on VRPPD, CVRP, and VRPTW has been conducted with PRISMA as described in Figure 1. The researchers adopted PRISMA as the trusted guidelines [8] to search, select and screen relevant articles and incorporate the findings [9]. PRISMA allows them to have a detailed and systematic literature search, a thorough article selection process, and clarity and transparency in the review process [10].

To ensure an organized literature search and analysis, the following research questions and objectives were identified:

Research questions:

1. What are the main challenges and issues facing VRPPD, CVRP, and VRPTW?
2. What are the existing algorithms and solution methods for VRPPD, CVRP, and VRPTW?
3. What are the future research directions and trends in VRPPD, CVRP, and VRPTW?

Research objectives:

1. To provide a comprehensive analysis of the main challenges and problems facing VRPPD, CVRP, and VRPTW.
2. To review and summarize existing algorithms and solution methods for VRPPD, CVRP, and VRPTW.

3. To identify and discuss future research directions and trends in VRPPD, CVRP, and VRPTW.

A comprehensive literature search was conducted using the Watase Uake software following the PRISMA methodology, which consists of the identification, screening, eligibility, and inclusion stages. Three primary keywords, namely "VRP Pickup and Delivery," "VRPTW," and "CVRP," were used to search publications from 2014 to 2024. The inclusion criteria comprised peer-reviewed journal articles published within the specified period, indexed in quartiles Q1–Q4, and accessible in full text. Articles that did not satisfy these criteria were excluded after a detailed review of their full texts to ensure relevance to the research objectives.

The selected studies were subsequently synthesized using tabular and diagrammatic presentations to facilitate comparison of the core findings, identify recurring themes, and reveal emerging trends across the three VRP variants. This synthesis also enabled the identification of research gaps and potential future directions, including algorithm optimization, the integration of artificial intelligence and machine learning, and environmentally sustainable solutions that consider operational uncertainty and additional modeling variables. Finally, the review was evaluated by comparing recent studies with earlier findings to assess the impact of new developments and ensure that the synthesized literature remains current, comprehensive, and relevant as a foundation for future research. The entire study selection process is illustrated using a PRISMA flow diagram.

3 Result and Discussion

The initial identification stage of systematic overview of VRP by PRISMA flow chart was depicted in Figure 1. From all the keywords, Watase Uake database has search result viz: VRP Pickup and Delivery resulted 9 articles, VRPTW resulted 18 articles, while CVRP resulted 30 articles.

The next processes, screening and filtering process, reported several results. The screening and the filtering results showed no duplicate articles and no articles without abstracts. 10 articles were not published in 2014-2024 and 4 articles were not in the Quartile criteria. During the next process, the eligibility stage, the remaining articles had to go through full – text filtering and resulted rejection of 18 articles as they did not match the inclusion criteria. The final result was that 25 articles could be processed. Thus, the filtering results processed from all the keywords with Watase Uake database has search results as follow: VRP Pickup and Delivery resulted in the search for 7 articles, VRPTW resulted in the search for 8 articles, and CVRP resulted in the search for 10 articles. Figure 1 shows that the 25 included articles were analyzed to provide an overview of key challenges, existing algorithms, evaluation metrics, and potential research directions in VRPPD, CVRP, and VRPTW.

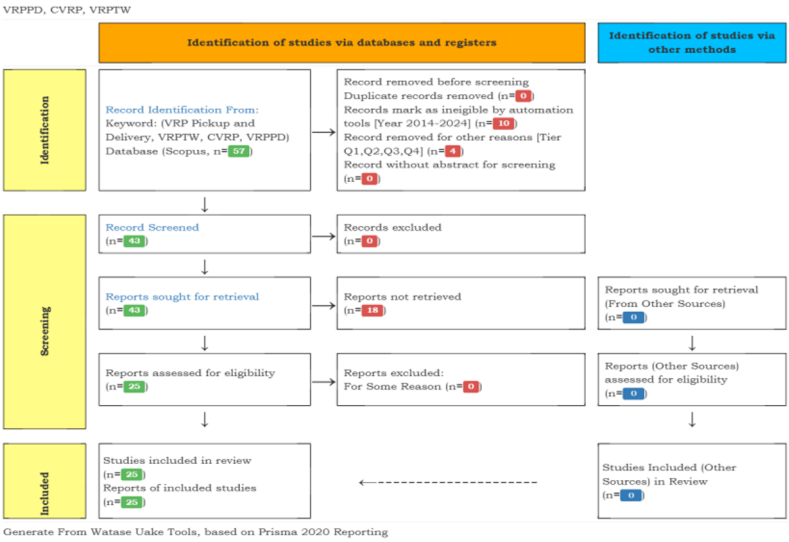

Fig. 1. PRISMA Flowchart

A selection process based on PRISMA identified several relevant studies, which were then analyzed to address the research topic.

The analysis reveals that vehicle capacity limitations represent the most significant challenge (34% of the identified issues), followed by retrieval optimization (26.5%) and efficient dispatch (20.4%). The time window limitations constitute the least reported problem (18.4%).

In terms of solution approaches, hybrid methods dominate the literature (44%), followed by heuristic (20%), metaheuristic (16%), exact (12%), and other methods (8%), so that they indicate a growing trend toward combining multiple techniques to enhance performance. Across problem variants (VRPPD, CVRP, and VRPTW, commonly applied algorithms include Integer Linear Programming, Local Search, Genetic Algorithms, Tabu Search, Simulated Annealing, Particle Swarm Optimization, and other metaheuristic-based approaches. Furthermore, future research trends highlight an increasing focus on handling more complex constraints, improving algorithm performance, incorporating multi-objective optimization.

4 Conclusion

This research provides a comprehensive review of recent developments in the Vehicle Routing Problem (VRP), with a focus on VRPPD, CVRP, and VRPTW variants over the last ten years (2014-2024) totaling 43 screening results and the final results after retrieval and include 25 articles. Overall, this research successfully achieved its goal of providing a comprehensive analysis of the main challenges and issues in solution methods using algorithms as well as research trends, for effective problem solving related to

VRPPD, CVRP, and VRPTW. These findings provide a strong foundation for researchers and practitioners to develop more efficient solutions and the most common problem faced by VRPPD, CVRP, and VRPTW is the vehicle capacity problem at 34.7% compared to other problems. In this SLR, hybrid methods, which account for 44% of all methods studied. Such as Meta-heuristics for VRP with pickup and delivery problem in CVRP, Branch and price algorithm with cluster decomposition in VRPPD, and hybrid multi objective evolutionary method for VRPTW in VRPTW from the three problems that Genetic Algorithms (GA) algorithm is a frequently used solution. This research also highlights the importance of further evaluation and development to ensure the practical application of the various approaches proposed in the conclusions to the method problems and solutions encountered from CVRP, VRPPD, and VRPTW.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Moghdani, R., Salimifard, K., Demir, E., Benyettou, A.: The green vehicle routing problem: a systematic literature review. J. Clean. Prod. 279, 123691 (2021). https://doi.org/10.1016/j.jclepro.2020.123691
2. Vidal, T., Laporte, G., Matl, P.: A concise guide to existing and emerging vehicle routing problem variants. arXiv preprint arXiv:1906.06750 (2019). http://arxiv.org/abs/1906.06750
3. Sabet, S., Farooq, B.: Green vehicle routing problem: state of the art and future directions. IEEE Access 10, 101622–101642 (2022). https://doi.org/10.1109/ACCESS.2022.3208899
4. Li, B., Wu, G., He, Y., Fan, M., Pedrycz, W.: An overview and experimental study of learning-based optimization algorithms for the vehicle routing problem. IEEE/CAA J. Autom. Sin. 9(7), 1115–1138 (2022)
5. Ancele, Y., Hà, M.H., Lersteau, C., Ben Matellini, D., Nguyen, T.T.: Toward a more flexible VRP with pickup and delivery allowing consolidations. Transp. Res. Part C Emerg. Technol. 128, 103077 (2021). https://doi.org/10.1016/j.trc.2021.103077
6. Ferreira, J.C., Steiner, M.T.A., Canciglieri Junior, O.: Multi-objective optimization for the green vehicle routing problem: a systematic literature review and future directions. Cogent Eng. 7(1), 1807082 (2020). https://doi.org/10.1080/23311916.2020.1807082
7. O'Dea, R.E., et al.: Preferred reporting items for systematic reviews and meta-analyses in ecology and evolutionary biology: a PRISMA extension. Biol. Rev. 96(5), 1695–1722 (2021). https://doi.org/10.1111/brv.12721
8. Rethlefsen, M.L., et al.: PRISMA-S: an extension to the PRISMA Statement for reporting literature searches in systematic reviews. Syst. Rev. 10(1) (2021). https://doi.org/10.1186/s13643-020-01542-z
9. Page, M.J., et al.: The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372, n71 (2021). https://doi.org/10.1136/bmj.n71
10. Ben Ticha, H., Absi, N., Feillet, D., Quilliot, A.: Empirical analysis for the VRPTW with a multigraph representation for the road network. Comput. Oper. Res. 88, 103–116 (2017). https://doi.org/10.1016/j.cor.2017.06.024

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