

OPTIMIZATION IN THE COURIER INDUSTRY: A COMPREHENSIVE SYSTEMATIC LITERATURE REVIEW (SLR)

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ABSTRACT

The courier industry is critical in today's fast-paced global economy, where efficient and cost-effective delivery services are in high demand. As customer expectations continue to rise, courier companies face mounting pressure to optimize their operations and streamline delivery processes. In response to these challenges, researchers and practitioners have increasingly turned to mathematical programming approaches to achieve enhanced efficiency, reduced costs, and improved customer satisfaction. The objective of this review paper is to review, analyze, and classify the existing work of literature related to optimization in the courier industry and to provide research directions. In this Systematic Literature Review (SLR), we collected, summarized, and analyzed research articles on the topic of optimization in the courier industry which were published between the years 2007 to 2022. We conducted this review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a rigorous and transparent approach in analyzing relevant research articles related to optimization in the courier industry. Articles were searched using keywords, forward reference searching, and backward reference searching to search all the articles related to the topic. 15 articles were chosen for this SLR after carefully following the screening process for the study.

Keywords: Courier services, Optimization, Systematic Literature Review.

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1. Introduction

In today's fast-paced courier industry, meeting customer expectations while ensuring profitability and sustainability poses significant challenges. Optimization techniques have emerged as essential tools for streamlining operations, reducing costs, and enhancing performance (Sugiarto et al., 2023). This systematic literature review aims to comprehensively explore optimization methodologies within the courier industry. By identifying research gaps and proposing future directions, this review seeks to foster innovation and collaboration, propelling the courier industry towards greater efficiency, sustainability, and customer-centricity. In this paper, the main objectives are to conduct a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, with the primary focus on reviewing, analyzing, and classifying the existing literature on optimization in the courier industry. By employing the PRISMA framework, we ensure a



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rigorous and comprehensive methodology for identifying, screening and synthesizing relevant research articles.

Through this systematic literature review (SLR), we aim to investigate the prevailing research trends in the field of courier industry optimization, gaining insights into the objectives of each study, their applications, and the methodologies employed. Our thorough analysis aims to provide a comprehensive and structured overview of the body of knowledge surrounding this subject, facilitating a deeper understanding of the various approaches and findings related to optimization in the courier industry. As a result of our analysis, we have categorized the collected literature into distinct themes, which are presented in Table 1. This categorization allows for a clearer presentation of the diverse topics and research directions covered within the realm of courier industry optimization. By identifying these themes, we contribute to the knowledge base by highlighting the key areas of interest and potential avenues for future research in this rapidly evolving domain.

Table 1: Themes of the study

No.	Themes of the Study
1.	Objective of the Study
2.	Application
3.	Methodology

One of the definitions of optimizing a decision choice is to be able to maximize expected utility (Klein, 2002). Optimization, a powerful and versatile concept, lies at the core of problem-solving and decision-making processes across numerous disciplines and industries. It represents finding the best solutions among feasible alternatives that satisfy all the constraints (Ciardiello et al., 2020). As the world becomes increasingly complex and interconnected, the significance and relevance of optimization have never been more apparent. The significance of optimization extends to both academia and industry. In research, optimization is a powerful tool to obtain the desired design parameters and best set of operating conditions (Alwan, 2020). In industry, it is a catalyst for driving innovation, enhancing productivity, and gaining a competitive edge (Aarstad et al., 2016; McCormack & Johnson, 2001). One domain that has particularly benefited from the application of optimization techniques is the courier industry. The courier industry plays a pivotal role in today's fast-paced global economy, where the swift and seamless movement of goods is critical for businesses and consumers alike.

The activities performed by postal operators, encompassing clearing, sorting, transportation, and delivery of registered items or postal parcels, constitute the dynamic realm of courier services (Dąbrowski, 2018). In recent years, the courier, express, and parcel (CEP) industry has experienced remarkable growth, particularly in developing nations. This expansion is driven by factors such as the burgeoning middle-class population, increasing affluence, rapid advancements in living standards, and the widespread adoption of the Internet and online trading (Ejdys & Gulc, 2020). In Malaysia, both the national postal service and private courier companies have made substantial contributions to the national economy and have become significant sources of employment (Noordin et al., 2012). Furthermore, courier services play a crucial role in facilitating international trade and communication within an increasingly globalized world. The demand for such services is driven by the urgent need for companies to compete and thrive in their respective markets by ensuring the delivery of products and documents in the right quantities, at the right locations, and within the right timeframe (Izzah et al., 2016). This emphasizes the pivotal role played by courier services in simplifying the transportation and delivery of goods and documents, thus enabling seamless trade and business operations. According to Statista Research Department (2022), around 737.36 million domestic courier items were delivered by courier service providers in Malaysia in 2021. In this dynamic landscape, optimization techniques offer immense significance, relevance, and transformative

potential, empowering courier companies to revolutionize their operations and deliver superior services.

2. Methodology

SLR is a research method that involves a rigorous and systematic approach to reviewing and synthesizing existing literature on a specific topic, providing a concise summary of the best available evidence using explicit and rigorous methods to identify, critically appraise, and synthesize relevant studies (Boell & Cecez-Kecmanovic, 2015). The main purpose of an SLR is to minimize bias and ensure objectivity by adhering to a predefined set of scientific methods and criteria during the literature search, selection, and analysis processes. By following a systematic approach, SLR aims to minimize errors and provide a comprehensive, reliable, and unbiased overview of the available evidence related to the research question or topic of interest. This method is widely used in academic and scientific research to gather and evaluate existing knowledge and to identify gaps and areas for further investigation. Figure 1 below shows the methodical approach to answering this research question. Furthermore, based on the results of the data search as illustrated in the chart above, 18 articles were further analyzed. The identity of the articles is summarized in Table 2.

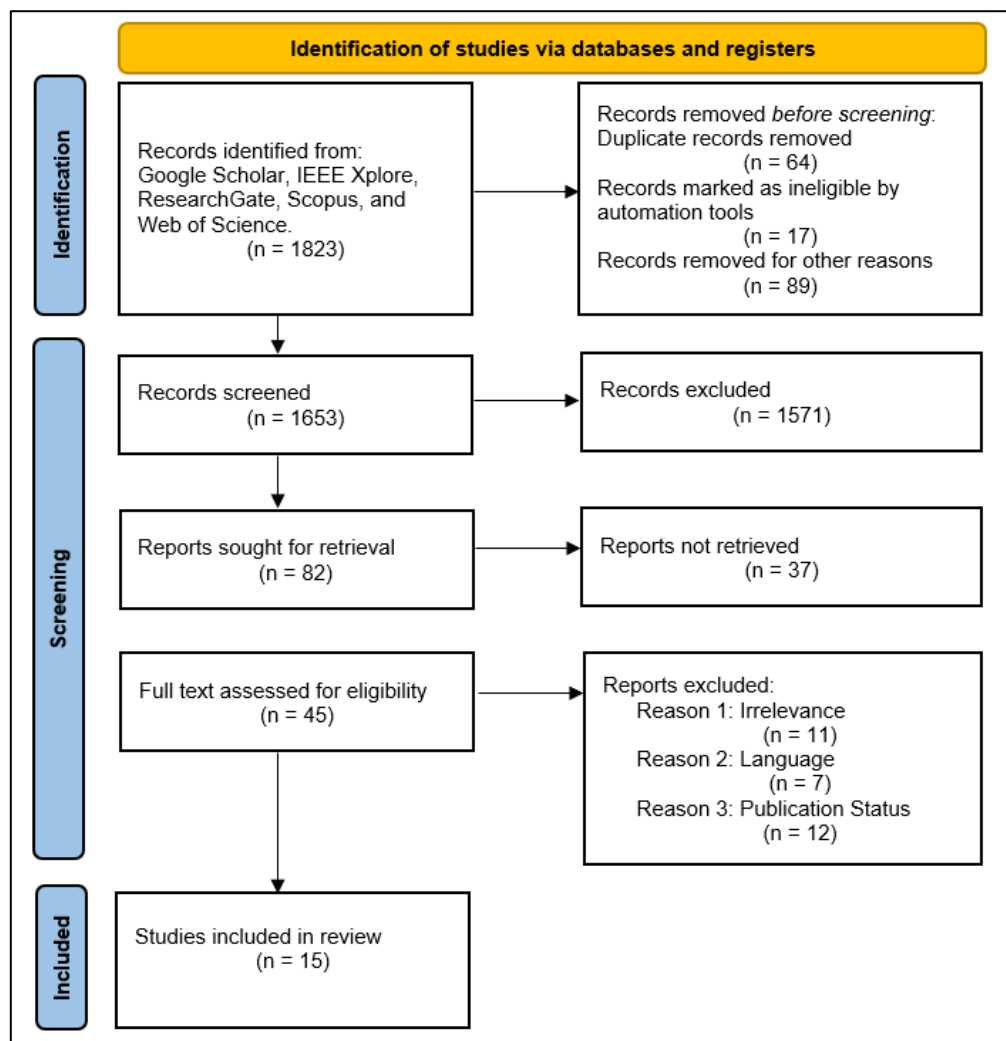


Figure 1: Research Data Search and Selection Flow

Table 2: Identity of the Articles to be Analyzed Further

No.	Article's Title	Year	Author's Name	Journal Name
1.	A decision support system for optimizing dynamic courier routing operations (Lin et al., 2014).	2014	Canhong Lin K.L. Choy G.T.S. Ho H.Y. Lam K.H. Pang K.S. Chin	Expert Systems with Applications
2.	Optimization of Courier Travel Routes Using Genetic Algorithms (Istiono, 2020).	2020	Wirawan Istiono	International Journal of Advanced Studies in Computer Science & Engineering
3.	A hybrid expert system, clustering and ant colony optimization approach for scheduling and routing problems in courier services (López-Santana et al., 2018).	2018	Eduyn López-Santanaa William Camilo Rodríguez-Vásquez Germán Méndez-Giraldo	International Journal of Industrial Engineering Computations
4.	A modified ant colony system for solving the travelling salesman problem with time windows (Cheng & Mao, 2007).	2007	Chi-Bin Cheng Chun-Pin Mao	Mathematical and Computer Modelling
5.	Formulations for Minimizing Tour Duration of the Traveling Salesman Problem with Time Windows (Kara & Derya, 2015).	2015	Imdat Kara Tusan Derya	4 th World Conference on Business, Economics and Management, WCBEM
6.	System Optimization Courier and Parcel in Cities (López et al., 2014).	2014	José Antonio Vera López Ana Belén Pabón Dueñas Roberto José Liñán Ruiz Salvador Merino Córdoba	XI Congress of Transportation Engineering
7.	Optimization of logistics services in hospitals (Rais et al., 2018).	2018	Abdur Rais Filipe Alvelos Joao Figueiredo Ana Nobre	International Transactions in Operational Research
8.	Optimizing Courier Routes in Central Business Districts (Thompson et al., 2018).	2018	Russell G. Thompson Lele Zhang Michael Stokoe	City Logistics 1: New Opportunities and Challenges

No.	Article's Title	Year	Author's Name	Journal Name
9.	A Mathematical Model for Delivery Zone Groups Based on Courier Assignment Optimization: A Case Study in a Logistics Service Provider (Kurniawan & Puspitasari, 2020).	2020	V. Reza Bayu Kurniawan Fransiska Hernina Puspitasari	Spektrum Industri
10.	Optimization of couriers' routes by determining best route for distributing parcels in urban traffic (Chrzczonowicz & Woda, 2015).	2015	Piotr Chrzczonowicz Marek Woda	Advances in Intelligent Systems and Computing
11.	Package delivery route optimization with tight travel time (Komarudin & Abyantara, 2019).	2019	Komarudin Apratimadewi Nuraziza Abyantara	ACM International Conference Proceeding Series
12.	Route Optimizations Using Clustering and Genetic Algorithms (Mustață et al., 2020).	2020	Alexandru – Ionut MUSTAȚĂ Tudor – Robert TUDORUȚ Anca MORAR	U.P.B. Sci. Bull., Series C
13.	Capacitated vehicle routing problem with time windows: A linear model and a case study of express courier (Casella et al., 2020).	2020	Giorgia Casella Sara Carattini Teresa Murino Letizia Tebaldi Eleonora Bottani	22 nd International Conference on Harbor, Maritime and Multimodal Logistics Modelling and Simulation, HMS 2020
14.	Optimization of the Logistics of a Courier Business (Moussaid et al., 2009).	2009	Khalid Moussaid Mohamed Azouazi Amina EL Omri	Applied Mathematical Sciences
15.	Modeling of emergency support capacity and optimization of delivery service system for urban living materials under uncertain situations: A case study of Xi'an City during COVID-19 epidemic (Wang et al., 2022).	2022	Jianpo Wang Gang Li1 Jiaobei Wang Qifan Nie Yue Yu Tingting Xu	Computational Urban Science

3. Data Collection and Analysis

Data collection for this research involved comprehensive searches of electronic databases, including Google Scholar, IEEE Xplore, ResearchGate, Scopus, and Web of Science. To ensure a thorough search, several keywords such as “optimization,” “courier industry,” “courier

services,” and “linear programming” were used. These keywords were carefully selected following the PRISMA guidelines, guaranteeing a systematic and transparent approach to identifying relevant literature. The inclusion criteria were limited to articles published by reputable scientific journals, ensuring the quality and reliability of the data. The collected data from these selected articles are presented in Table 3, offering valuable insights into the research findings and enabling a deeper analysis of the various optimization approaches and outcomes within the courier industry.

Table 3: Data collected from the articles

No.	Article’s Title	Objective of the Study	Application	Methodology
1.	A decision support system for optimizing dynamic courier routing operations	To propose a prototype of a decision support system (DSS) that integrates a hybrid neighborhood search algorithm to solve the offline and online routing problems arising in courier service.	Courier service Customer	ILP & NLIP
2.	Optimization of Courier Travel Routes Using Genetic Algorithms	To obtain travel route optimization in courier service transactions, which is the condition where the best combination occurs for the path traveled and fast travel times, so that the courier can deliver goods to all customers with optimal time.	Courier service	NLIP
3.	A hybrid expert system, clustering and ant colony optimization approach for scheduling and routing problem in courier services	To solve the routing problem, we use an Ant Colony Optimization metaheuristic.	Courier service Customer	NLIP
4.	A modified ant colony system for solving the travelling salesman problem with time windows	To develop a modified ant algorithm, named ACS-TSPTW, based on the ACO technique to solve the TSPTW.	Courier service	NLIP
5.	Formulations for Minimizing Tour Duration of the Traveling Salesman Problem with Time Windows	To minimize the tour duration by using the polynomial size integer linear programming formulation for symmetric and asymmetric TSPTW separately.	Customer	ILP

No.	Article's Title	Objective of the Study	Application	Methodology
6.	System Optimization Courier and Parcel in Cities	To study the distribution networks in order to reduce the costs in this phase. It can achieve efficiency in distribution and in quality.	Courier service	MILP
7.	Optimization of logistics services in hospitals	To demonstrate how efficiency and effectiveness can be improved by applying optimization-based approaches on real-world data from a particular hospital in Portugal	Logistics service	IPM
8.	Optimizing Courier Routes in Central Business Districts	To develop a model, formulated as a bi-level optimization problem. To determine the optimal on-street loading zones for courier vehicles to use to minimize distribution costs.	Courier service	BLIP
9.	A Mathematical Model for Delivery Zone Groups Based on Courier Assignment Optimization: A Case Study in a Logistics Service Provider	To minimize total distances through optimal zone groups under several restrictions.	Courier service	LP
10.	Optimization of couriers' routes by determining best route for distributing parcels in urban traffic	To propose an efficient algorithm for determining the best route for couriers in urban traffic.	Courier service	ILP
11.	Package delivery route optimization with tight travel time	This study focuses on designing method that could answer the main decisions in hub-and-spoke network design—which are: the optimal number and locations of hubs, along with the allocations of other nodes to hubs—and to transform such hub-and-spoke network design into a routed one which	Delivery service	MILP

No.	Article's Title	Objective of the Study	Application	Methodology
		fulfills both tight travel time and minimization of vehicles needed.		
12.	Route Optimizations Using Clustering and Genetic Algorithms	To propose a new artificial intelligence route planning algorithm that solves the "Last Mile Delivery" problem. To compare the result with existing solutions.	Delivery service	ILP
13.	Capacitated vehicle routing problem with time windows: A linear model and a case study of express courier	To investigate the issue of minimizing the delivery travel time of a real company located in the South of Italy and operating as a courier, express and parcel (CEP) service provider. To optimize the deliveries to the customers for the targeted company.	Courier service	ILP
14.	Optimization of the Logistics of a Courier Business	To reduce its cost and enhance the quality of the service delivered.	Courier service	ILP
15.	Modeling of emergency support capacity and optimization of delivery service system for urban living materials under uncertain situations: a case study of Xi'an City during COVID-19 epidemic	To build and optimize the urban emergency support and delivery service system to improve the comprehensive ability of the city to cope with uncertain risks.	Delivery service	NLIP

*ILP: Integer Linear Programming; NLIP: Non-linear Integer Programming; MILP: Mixed Integer Programming; IPM: Integer Programming Model; BLIP: Bi-level Integer Programming; LP: Linear Programming

4. Results and Discussions

From Table 3, we can conclude that there are similarities in the objectives of the studies. The selected articles share common objectives, primarily revolving around the optimization of travel routes and delivery processes within the courier industry. Many studies explore the application of optimization algorithms, such as Ant Colony Optimization (ACO) and other metaheuristics, to effectively address routing problems in courier services. An overarching theme present in multiple articles is the aspiration to minimize costs and improve operational efficiency, indicating the industry's persistent pursuit of cost-effective solutions. Moreover,

enhancing the overall quality of service delivery is a key focus among various studies, reflecting the industry's commitment to meeting customer expectations and satisfaction. Additionally, several articles place significant emphasis on reducing tour durations and total distances in courier operations, highlighting the crucial role of efficient logistics and route planning in the context of courier services.

However, there are differences in the objectives of the studies as well. Specific algorithms and techniques used for optimization vary among the articles, such as hybrid neighborhood search algorithms, bi-level optimization problems, and artificial intelligence route planning algorithms. Some studies focus on particular aspects, like finding optimal on-street loading zones or determining the optimal number and locations of hubs in hub-and-spoke network design. While many articles focus on general courier services, some are specialized, such as urban emergency support and delivery services, food delivery services, and courier services operating in specific regions like South Italy. Certain articles aim to develop new models, formulations, or algorithms, while others compare existing solutions or apply optimization approaches to real-world data from specific settings like hospitals.

The application of optimization techniques is evident across various domains in the context of courier and delivery services as well as logistics. Table 4 below shows the application of optimization in the courier industry.

Table 4: Application of optimization in the courier industry

Application	Courier service	Courier service and Customer	Customer	Delivery service	Logistics
n	8	2	1	3	1

Optimization plays a pivotal role in the courier service industry, where timely and efficient delivery of packages is essential. By employing optimization algorithms, courier companies can optimize their delivery routes, minimize travel distances, and improve the overall efficiency of their operations. Consequently, this leads to reduced delivery times, enhanced customer satisfaction, and cost savings for the company. Furthermore, the optimization techniques are applied in this context to cater to customer-specific needs efficiently. For instance, this could involve determining optimal delivery time windows, preferred delivery locations, and optimal route planning to reduce delivery time and cost, ensuring a positive customer experience. Moreover, optimization techniques can also be used to optimize customer-centric processes, such as scheduling service appointments or allocating resources based on customer demands. As a result, this ensures that customer needs are met in the most efficient and effective manner. In broader delivery services, on the other hand, optimization is employed to streamline the overall logistics and transportation processes. This includes optimizing vehicle routing, resource allocation, and delivery scheduling, ultimately resulting in reduced costs and improved service quality. Lastly, optimization is also applied in logistics to optimize the flow of goods, inventory management, and transportation operations. By optimizing the distribution networks and supply chain processes, logistics companies can achieve cost savings and improve overall operational efficiency.

The SLR encompassed a comprehensive collection of 15 articles published between the years 2007 and 2022, exploring various optimization techniques in the context of the courier industry. As shown in Table 5, among these articles, different types of optimization approaches were employed to address the diverse challenges and complexities of the courier service domain.

Table 5: Models implemented by the authors

No.	Author(s)	Year	Models
1.	Lin et al.	2014	ILP & NLIP
2.	Istiono	2020	NLIP
3.	López-Santana et al.	2018	NLIP
4.	Cheng & Mao	2007	NLIP
5.	Kara & Derya	2015	ILP
6.	López et al.	2014	MILP
7.	Rais et al.	2018	IPM
8.	Thompson et al.	2018	BLIP
9.	Kurniawan & Puspitasari	2020	LP
10.	Chrzczonowicz & Woda	2015	ILP
11.	Komarudin & Abyantara	2019	MILP
12.	Mustață et al.	2020	ILP
13.	Casella et al.	2020	ILP
14.	Moussaid et al.	2009	ILP
15.	Wang et al.	2022	NLIP

The review identified 1 article that utilized both Integer Linear Programming (ILP) and Non-Integer Linear Programming (NILP) techniques to optimize courier operations. These combined approaches demonstrated a comprehensive optimization strategy, leveraging the strengths of both ILP and NILP to achieve efficient and effective solutions. Furthermore, 4 articles exclusively focused on Non-Integer Linear Programming (NILP) as their chosen optimization method. This indicates the popularity and relevance of NILP in addressing complex routing and scheduling problems within courier services, where the need for fractional solutions arises. Additionally, 5 articles solely utilized Integer Linear Programming (ILP) techniques to optimize various aspects of courier operations. ILP is widely adopted due to its ability to handle discrete variables, making it suitable for solving problems that require integer or binary solutions.

Moreover, 2 articles employed Mixed-Integer Linear Programming (MILP) as their optimization approach. MILP combines the advantages of both ILP and Continuous Linear Programming, allowing for a more flexible optimization process that can handle mixed integer and continuous variables. The review also identified 1 article that applied Interior Point Method (IPM) in the optimization process. IPM is known for its efficiency in solving large-scale linear programming problems, providing viable solutions for courier industry challenges. Additionally, 1 article utilized Binary Linear Integer Programming (BLIP) techniques. BLIP is particularly effective in optimizing problems that require binary decision variables, offering a powerful approach for courier service optimization. Lastly, 1 article applied Linear Programming (LP) as its chosen optimization technique. LP is widely used for optimizing linear problems with continuous variables, and its application in the courier industry demonstrates its versatility in handling various operational challenges.

5. Conclusion

Optimization techniques find application in various industries and fields, offering improved efficiency and cost-effectiveness. For example, in logistics and transportation, route optimization algorithms are employed to minimize travel distances, reducing fuel consumption and delivery times. Thus, optimization has broad applications across industries, helping organizations enhance productivity, reduce expenses, and deliver better services. The inclusion of these 15 articles in the literature review showcases the diverse range of optimization techniques applied in the courier industry over the years. These findings offer valuable insights

into the methodologies employed by researchers and practitioners to enhance efficiency, reduce costs, and improve service quality in the dynamic and competitive landscape of the courier services domain.

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8. Conflict of Interest

The authors have no conflicts of interest to declare.

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