A survey of hybrid meta heuristic methods to solve location routing problems

Abstract

Typically, location routing problem (LRP) is one of the key features in Transportation theory. This is one of the NP-hard issues well studied in Transportation problem. Therefore, many different meta-heuristic techniques are presented to solve the problem and provide high performance. Seemingly, regardless of the importance of the nature-stimulated meta-heuristic methods to solve the LRP, there is not any inclusive report and detailed review about overviewing and investigating the crucial problems of the field. As a result, the present study introduces a wide-ranging reporting of nature- stimulated meta-heuristic methods, which are used throughout the location routing. The literature review contains a classification of significant techniques. This study mainly aims at emphasizing the optimization algorithms to handle the LRP problems. Furthermore, the advantages and disadvantages of the meta-heuristic algorithms in solving the LRP and their key issues are examined to offer more advanced meta-heuristic techniques in the future.

Keywords: Meta-heuristic, Location routing, Hybridization, Memetic algorithm

Introduction

A location routing problem (LRP) may be a combination of two separate or interrelated decision problems. Exactly, location and routing are one of the most important issues in optimization regarding the set of features, possible warehouses, and customer sets. The purpose of LRP is to provide better services to applicants and to consider various facilities (planning routes and warehouse locations). The goal is to minimize the total cost of reopening the facility warehouse and the cost of serving all applicants. When tackling such a problem, it is necessary to consider location and routing simultaneously given that ignoring routes when locating facilities obviously increases the cost of the distribution system and leads to the sub-optimal solutions proposed by Salhi and Rand (1989). Overall, from a complete supply chain management perspective, location and routing seem to act as two components of serious concern in real-life applications. For instance, locating regional blood banks to serve hospitals Or and Pierskalla (1979), or establishing journal mail delivery systems Jacobsen and Madsen (1980), or publishing goods parcels philanthropic–care network distribution dynasty (Perl and Daskin (1985), Wasner and Zäpfel (2004)), to recitation a few, handle location and routing problems together Obviously, this problem-solving procedure will be challenging for logistics managers and decision-makers.

Meta heuristics, as generic methods to lead the search via the solution space, exploit some forms of heuristics and local search as substitute algorithms. The meta-heuristic starts from the first quantity provided by some heuristics and iteratively modifies them until a stopping standard, which can be the elapsed time, the number of iterations and the number of evaluations of the objective function, etc., corresponds to the class be meta-heuristic. Methods based on their type such as simulated annealing, tabu search and genetic algorithms.
However, despite the significance of nature-inspired meta heuristic approach mechanisms and techniques in the location problem, as far as we know, there is no public and systematic study in the conditions of antecedents and backgrounds in this field. Therefore, this study aims to investigate the existing nature-inspired algorithms for location problem, evaluate the differences among the mentioned techniques, and scheme the serious competes and important issues about the location problem that could address the cloud domain. Generally, the main allotment of this paper can contribute to the following areas:

- Providing insights and implementations of location issue optimization techniques, as well as describing the nature of meta heuristic algorithm applications for the location problem.
- Highlighting the significance of the nature-inspired meta heuristic optimization algorithms, and the many benefits they provide to tackle the challenges encountered in the location problem.
- Determining the relevant open issues and some clues to solve the existing issues.

In this article, Section 2 presents the analysis and review of the related work. Section 3 provides the research terminologies and preparation mechanisms. Section 4 discusses the review of the selected meta-heuristic algorithms for LRP problems. Section 5 includes the taxonomies and analogies of the reviewed mechanisms. Section 6presents the same open issues. Finally, Section7 concludes the article.

Table 1 shows the jointly used abbreviation in the article.

Table 1. Table of abbreviations

Abbreviation	Definition	Abbreviation	Definition
LRP	Location Routing Problem	GA	Genetic algorithm
HM	Hybrid metahuristic	MA	Memetic algorithm
ACO	Ant colony optimization	PSO	Particle swarm optimization
HA	Hybrid Algorithm	HEA	Hybrid evolutionary algorithm
COA	Cuckoo optimization algorithm	TS	Tabu search
FA	Firefly algorithm	SA	Simulated annealing
SDO	Saturation degree based ordering	HGS	Hybrid Genetic simulated annealing
MFFA	Memetic firefly algorithm	ACS	Ant colony system
APSO	Particle swarm optimization		

2.Related work

Some LRP reviews have been conducted. In this section, we examine the review literature for location routing conditions or how to use the meta heuristic algorithms in LRP, and their weaknesses and strengths. This review was also conducted on articles from 2002 to 2025. A review of location-routing problem has been presented by Drexl and Schneider (2015) because cost minimization. They are unaware of any articles on the union of revenue management aspects into location-routing models. Their purpose of presenting more detailed excerpts making the central ideas and alone properties of any work is clear without the reader having to consult the original reference. Thus, both surveys are complementary. The survey is not considered to cover the complete literature.

One of the significant studies of the location-routing problems has been provided out by Prodhon and Prins (2014) . LRP integrates two types of intentions. Given the set of potential warehouses with variable costs, the same fleet of vehicles and the set of applicants with debt claims are available. Classic LRPs are used, including opening a subset of warehouses, assigning the applicant to them, and specifying vehicle routes, to minimize total costs such as assumed warehousing costs and fixed vehicle costs. They are also used throughout the project to minimize total costs. Since the last comprehensive scrutiny on LRP published by Nagy and Salhi (2007), the number of articles devoted to this issue has increased quickly, requiring a review of new research works. This article analyzes the recent literature (72 articles) on standard LRPs and new extensions like multiple distribution access. To summarize and conclude, the following research directions have been considered:

1. Design of precise methods exploiting most of the problem structures.

2. Development of united met heuristics to avoid the proliferation of much similar variants.

3. Design of more evolved collaboration mechanisms and use of recent computerarchitectures (grids and multicourse).

4. Problems were not all applicants can be served.

Vallada et al. (2008) Presented a review and extensive evaluation of heuristics and met heuristics for the m-machine stream shop scheduling problem aiming at minimizing general tardiness. He implemented 40various heuristics and met heuristics and examined their performance using the same criterion of instances. Their paper has presented an extensive and comprehensive review of heuristic and met heuristic procedures for the permutation flow department store scheduling problem aiming at minimizing the total tardiness. They have encrypted and tested 40 different algorithms to test their method performance under the same conditions. In addition, a benchmark is provided to evaluate all steps under a common dataset of 540 problems and a maximum of 350 related jobs and 50 new devices.

Notwithstanding, the important conditions of the met heuristic techniques in the location issue, a universal and systematic survey of the discussion on their categorization is not presented up to now. Additionally, the future challenges and the crucial role of the met heuristic techniques in a location problem are not presented appropriately. In general, the reviewed articles have several defective categories that are as follows:

- ☐ The articles selection process has not been identified well.
- ☐ Some authentic and written researches have not been scrutinized.
- ☐ Future operations and open issues are not well stated.
- ☐ The categorization of the approaches studied has not been properly described.
- ☐ The strengths and weaknesses of the reviewed articles are well highlighted.
- ☐ In many studies, few papers have been reviewed.

In this article, the next section discusses some questions about heuristic techniques in the routing and location problem, so that we can select the main studies to review the heuristic approaches to the location problem. Future challenges and trends will be answered by answering each of these questions.

3. Systematic literature review

To provide a clear picture of the meta-heuristic approach to the problem of location and routing, this section presents a systematic history review (SLR) of the proposed systems with a particular focus on location and routing research. Consistent with the study of Cook et al. (1997), a systematic review was distinguished from a standard one in the case of the replicable, theoretical, and transparent process. An SLR aims to provide a comprehensive summary of the linked literature to the research amplitudes(Aznoli and Navimipour, 2017).Inspired by the field of medicine (Kitchenham, 2004), SLR, as a research procedure, provides a repeated procedure in which supplying sufficient details for being regurgitated by other researchers is carried out in(Navimipour and Charband, 2016, Charband and Navimipour, 2016, Cook et al., 1997, Kupiainen et al., 2015). A thorough search of the literature for relevant spread studies is the first step in conducting a principled review(Soltani and Navimipour, 2016, Navimipour and Charband, 2016).This has been supported by foregone studies suggesting that this procedure for literature review can lead to limited systematic errors, reduced chance factors, and enhanced validity of data analyses (Aznoli and Navimipour, 2016, Navimipour and Charband, 2016, Aznoli and Navimipour, 2017).The research procedure to conduct SLR is supported by the guidelines proposed by Kitchenham et al. (2009) as well as Biolchini et al. (2005). The number of studies on recommender systems has increased dramatically; therefore, in this section, to conduct a comprehensive study of the important workmanship of the recommender system in the location issue, the required data were culled from the available SLR of 2009.

3.1 Search query

Investigation of articles is an necessary part of any research amplitude. In the electronic database, keywords are definitive to search the relevant theoretical published paper abstracts full articles. Hence, selection of pertinent key words is significant and useful to easily identify and search related sources and to relatively filter out all undesirable materials(Sharma and Mediratta, 2002). A search thread can be recognized by selecting the most suitable keywords regarding preparing our subject. The keywords discussed for this study are “hybridization”, “local search”, “location routing”, and “meta heuristic”.

3.2 Article selection process

To describe the keywords for various disciplines and exclusion criteria, the scientific database is used and linked together using Boolean and OR(Soltani and Navimipour, 2016). The electronic database is used according to the available recommendations, and the well-known electronic database is used in(Keele, 2007) and (Kitchenham et al., 2009). To conduct the review, we focused on searching in electronic databases such as Google scholar, Science direct, ACM Digital Library, IEEE, Wiley and Springer. The paper selection strategy consists of several important steps:

Stage1: Independent search relying on considered keywords.

Stage2: Elimination based on titles.
Stage3: Selection based on conclusions and abstracts.
Stage 4: Elimination based on full texts and abstracts

The search results for articles from journals, conference papers, books, notes, and any articles are presented in this study. This survey is based on both types of research articles: quantitative and qualitative written from 2005 to 2019 in English.Stage2 is optimized based on selected articles, and the search result is selected from 253 articles. In Stage3, the conclusions of the selected papers and abstracts are reviewed, and 65 articles are selected. In stage4, the articles obtained from stage3 are evaluated, and some are eliminated based on the problem needs. Finally, 47 articles are selected for further review. Table 2 shows the resulting articles based on their algorithms applied in practice.

Table 2. Distribution meta heuristic algorithms for location problem

Meta-heuristic algorithms	publisher	Year	Author	Title
Hybrid Algorithms (HA)	Elsevier	2013	Escobar et al. (2013)	A two-phase hybrid heuristic algorithm for the capacitated location-routing problem
	Elsevier	2016	Babaie-Kafaki et al. (2016)	Hybridizations of genetic algorithms and neighborhood search meta heuristics for fuzzy bus terminal location problems.

	IEEE	2013	Herazo-Padilla et al. (2013)	Coupling ant colony optimization and discrete-event simulation to solve a stochastic location
	Elsevier	2018	Pichka et al. (2018)	*The two echelon open location routing problem: Mathematical model and hybrid heuristic*
	Elsevier	2012	Marić et al. (2012)	Meta heuristic methods for solving the bilevel uncapacitated facility location problem with clients' preferences
	Elsevier	2014	Martínez-Salazar et al. (2014)	Solving a bi-objective Transportation Location Routing Problem by meta heuristic algorithms
	Elsevier	2014	Nekooghadirli et al. (2014)	Solving a new bi-objective location-routing-inventory problem in a distribution network by meta-heuristics
	Elsevier	2007	Rajagopalan et al. (2007)	Developing effective meta-heuristics for a probabilistic location model via experimental design
	Elsevier	2019	Tam et al. (2019)	Composite material identification using a two-stage meta-heuristic hybrid approach incorporated with a two-level FRF selection scheme
	Elsevier	2012	Sörensen et al. (2012)	Efficient meta heuristics to solve the intermodal terminal location problem
	IEEE	2005	Wang et al. (2005)	A two-phase hybrid heuristic search approach to the location-routing problem
	IEEE	2009	Qiu et al. (2009)	A new hybrid variable-length GA and PSO algorithm in continuous facility location problem with capacity and service level constraints
	IEEE	2002	Cong and Zhuang (2002)	Hybrid TDOA/AOA mobile user location for wideband CDMA cellular systems
	Hindawi	2012	Cabrera G et al. (2012)	A hybrid approach using an artificial Bee algorithm with mixed integer programming applied to a large-scale capacitated facility location problem
	Hindawi	2013	Li et al. (2013)	A Hybrid genetic-simulated annealing algorithm for the location-inventory-routing problem considering returns under E-Supply chain environment
	Elsevier	2013	Kanagaraj et al. (2013)	A hybrid cuckoo search and genetic algorithm for reliability–redundancy allocation problems
	IEEE	2010	Karaoglan and Altiparmak (2010)	A Hybrid genetic algorithm for the location-routing problem with simultaneous pickup and delivery
	Taylor & Francis	2013	Mousavi et al. (2013)	The capacitated multi-facility location–allocation problem with probabilistic customer location and demand: two hybrid meta-heuristic algorithms
	Semnan University	2023	(Zekavatmand et al., 2023)	A new way to obtain fixed point functions using the grey wolf optimizer algorithm
	Scientific Reports	2024	(Qiu et al., 2024)	An improved gray wolf optimization algorithm solving to functional optimization and

				engineering design problems
	Taylor & Francis	2025	(Esmaeeli et al., 2025)	Optimizing truck scheduling and dock placement at cross-docking systems through a hybrid genetic-ant colony optimization algorithm
	Springer	2024	(Sahebi et al., 2024)	Presenting an optimization model for multi cross-docking rescheduling location problem with metaheuristic algorithms

4. Review meta-heuristic algorithms in location problem

In this section, we review the selected studies to meta-heuristic algorithms in the location problem. As for selecting in Section 3, we surveyed meta-heuristic algorithms in groups of ant colony optimization (ACO), genetic algorithm (GA), particle swarm optimization (PSO), firefly optimization (FA), tabu search (TS), simulated annealing (SA), memetic algorithm (MA) and hybrid algorithms (HA). Qualitative criteria for the location problem include execution times, comparisons, real plans, competitiveness, future development, algorithm improvements, parameter constraints, reduction of solution space and success.

4.1 Hybridization of meta heuristic algorithms technique

At present, combining the members of different procedures is one of the best and most prosperous trends in optimization. Meta-cognitive hybridization, such as ants' evolution and optimization algorithms and the search for variable neighborhoods with artificial intellect techniques and operational research, plays assignificantrole. The resulting hybrid algorithms are commonly labeled as hybrid meta-heuristics. An increase in this new research field is because the basis of optimization research has moved from an algorithmic point of view to an uncertain point. In this concise review of hybrid procedures, we review an overview of some of the most compelling and most representative developments. Interested readers can find other studies on hybrid methods in (Blum et al., 2008, Cotta-Porras, 1998, Dunker et al., 2005, Raidl, 2006).

4.1.1 Overview of the selected mechanism

Escobar et al. (2013) *p*roposed a two-phase hybrid heuristic procedure to solve the capacitive location routing problem (CLRP). TheCLRP procedure checks the location and routing intention. They are at the arrival of a set of identical vehicles (each with a fixed cost and capacity), a set of offices with bounded arm costs of bounded capacity, and a set of customers with a decisive demand. The results of the practical calculations show that the proposed framework can solve other problems such as a periodic routing problem (PLRP), and multipliers routing problems (MDVRP) and several CLRP extensions. In other words, addition of constraints such as windows time and heterogeneous fleet becomes a problem. In general, the proposed method is desirable in terms of computational time compared to similar methods. Never the less. it has some limitations compared to real problems.

Pichka et al. (2018) developed an integrated logistics procedurein which the main decisions are made about the location of the storage, the allocation of the way to the vehicle and the vehicle's transportation concurrently. The equilibrium proficiency of the common decision criteria and total system costs shows that concurrent versions have capacity constraints over successive issues, but they are not temporally opposed to each other. Simultaneous versions are also the most effective productive non-dominant solutions compared to sequential versions. This procedure considers both problems at the same time and tries to reduce costs, but in terms of the efficiency and timing of the checks, the situation is not favorable.

Marić et al. (2012) presented a type of Bilevel inaccessible housing problem (BLUFLP) in which clients select project suppliers based on their preferences. Additionally, in this regard, computational tests have investigated the difficulty in cases of large-scale problematic examples. It showed exceptional performance regarding solution quality, stability and running times. The RVNS-VNS represents a promising meta-heuristic to solve BLUFLP and has the potential to be applied to solve similar facility location problems. With this situation, the approach presented has acceptable performance in dealing with real issues.

Martínez-Salazar et al. (2014) presented a transportation location routing problem (TLRP) that could be regarded as a development of the two phase location routing problem in which the first phase corresponds to a transport problem with truck capacity. Two main goals in this research, namely the balance of workload for drivers in the routing phase and the reduction of the cost of broadcast, are discussed. They recommend a mathematical formula for TLRP and suggest a new suggestion for TLRP based on the preferences of the problem. In two heuristic procedures, a local-based search (SSPMO) technique and a deviation technique (NSGA-II) have been presented. Implementation of prioritization in SSPMO has led to a reliable approach with appropriate algorithms, as can be seen by measuring the solutions obtained with SSPMO with the precise solution and NSGA-II. Compared to the rigorous procedure, SSPMO achieves qualitative results while reducing time. On real scales with NSGA-II, SSPMO was the best solution for small samples, but when the sample size increased, NSGA-II provided better estimates.

Nekooghadirli et al. (2014) presented a modern bi-objective location-routing-inventory (LRI) pattern discussing a multi-period and multi-product process. This model considers possible travel time among purchasers. To do this, four comparable metrics (for example, interval, quality, variation and ideal distance) were carried. The pertinent results indicate that the presented MOICA has executed better than previous systems. The development of meta-explorations for the specified problem can be another absorbing research route. In addition, analysis of a model under indefiniteness in each parameter and time interval can be an inestimable topic for study.

Rajagopalan et al. (2007) presented a statistical empirical design to guide and evaluate the expansion of four meta-heuristics feasible to a probabilistic location model. Appraised meta-heuristic locates evolutionary algorithms, simulated annealing, taboo search, and hybrid climbing algorithm. The categorical results were analyzed using ANOVA. These intuitions show that all four solutions produce the right modality solutions. Specifically, it was found that the medium taboo search and simulation analysis obtained their best solutions in a minimal value of time with relatively small variations. This is mainly significant for large projects, when kinetic reengineering is needed, especially for large projects. In reengineering, he obtains a clear and unbiased assessment of how each activity works for this issue. Their science is that the first is that several satellites are regularly developed and applied to the maximum envisaged housing habitat (MEXCLP). This licensed them to objectively evaluate the efficiency of various meta-explorations for a particular problem. A good effort was made to encode each method with 2000 applicants, and 2000 potential facility locations achieved good performance from all three previous methods. Even in the large problem dimensions, the proposed RVNS-VNS method is better than the PSO and SA methods in terms of quality of solutions and runtime activities. In particular, overlays use shared data representations, shared evaluation performance, and a shared jump operator.

Tam et al. (2019) examined the performance of a copy of the meta-heuristic an heuristic centralization, which they called HC:1-2-1 on a procedure to which it had not formerly been applied; the maximal inclusive location problem. This problem includes many different fields; therefore, a solution procedure that is fast and effective when traditional procedures are not is highly desirable. This procedure combines (1) a sequence of runs of a 1-opt vertex interchange heuristic with (2) a 2-opt exchange performed on a smaller desirable set and with (3) a final 1-opt interchange in order to find optimal and near-optimal solutions. They applied HC: 1-2-1 to the maximal location problem with procedures containing 900 nodes and 10–20 facilities. The exact solutions to these procedures were also produced using LP-IP (that is linear programming plus split and bound) for examples in which the LP-IP run time was less than ~ 1.5 days. For these randomly generated issues, they found that HC: 1-2-1 found solutions with purpose values at most0.543% from the optimal purpose value. Furthermore, the run time of HC: 1-2-1 was considerably shorter than that of LP-IP in high percentage coverage (high distance standard) instances and competitive in all cases.

Sörensen et al. (2012) provided a place for the ***transport station***. The problem is to specify which ***station*** sets to use and how to guide the supply and request of a set of customers through the system so that the total cost of the system is minimized. There are two different meta-heuristic procedure, both of which include two steps: a solution combination and a recovery phase based on local search. Introduction in this approach is the integration of a quick-exploration procedure to approximate the total cost of an open set of ***station***s. Both metaheuristics are measured with the results of a MIP intention maker. A thorough evaluation of the methods shows that both meta-cognitions provide almost optimal solutions at a reasonable computational time. The argument in favor of the ABHC approach is that it should be run without parameters; therefore, it can be more transparent and in a business environment with relevant constraints to reduce costs.

Wang et al. (2005) proposed a two-phase hybrid heuristic search procedure converting the location-routing issue into a vehicle routing issue and a location-allocation problem. For each of the location formations, ant colony algorithm is run on the routing uncertain to obtain a good routing for the certain configuration. In the routing process of this procedure, the main problem can then be categorized into smaller subsets. This not only ameliorates efficiency, but also improves the proficiency of the procedure. The meaning of parsing at different levels prepares a new approach to solving a complex issue. The proposed technique with exploratory approach has been experimented on three issues and has been compared to equivalent results. The experiments results indicate that this method has better performance considering the time consumed and the quality of the solution. However, due to the lack of parameters in real problems, there is a problem and needs to be developed in this regard.

Qiu et al. (2009) considered a continuous capacitated instrument location problem without a priori cognition of the desired number of facilities. The requested locations and volume are known to the intention maker. They use the hybrid variable-PSO and GA (GA-PSO) procedure to solve the issue of continuous facility location and function level constraints. Furthermore, temporarily, an external population of thecapacitor of unacceptable solutions is suggested to reapply potential solutions effectively. This work has been developed as a forerunner to RCP. Applications in business records show the good performance and quality of PSO-GA in relation to the PSO and GA performance that is used alone. Furthermore, this method generally yields good results regarding the parameters of real problems and computational time.

Cong and Zhuang (2002) have proposed a mobile location targeting program for multi-purpose radio (CDMA) wireless communications systems. In order to obtain location precision and minimize mobile phone expense for users, the procedure used was to map the location, measurement the time diversity (TDOA) from the AOA signal from the pilot signal inverse. And in general, the applied procedure included the following characteristics.

1) The TDOA / AOA scheme works premier than TDOA, especially when measurement (AOA) uses accurate scales.

2) Additional notification (AOA) examines the ambiguity issue in the layout (1-D) array (BS).

3) The Taylor series algorithm has a partly better accuracy compared to the two-stage LS algorithm; however, there must be a preliminary surmise at the MS position and may have a sync issue.

4) The biphasic method (LS) works well in most cases, even when the MS is near position (BS).

Cabrera G et al. (2012) presented hybridization of two disparate approaches practical to the well-known capacitated facility location problem CFL. The Artificial Bee algorithm BAis exploited to select a promising subset of locations ware room solely contained in the mixed integer programming MIP cast. They demonstrate that BA can be significantly amended using the MIP algorithm. Meanwhile, their hybrid implementation of the MIP algorithm permits us to arrive at a desirable solution over a considerably shorter time. There is no need to solve the specimen using the entire dataset directly inside the specimen. Their combined method and the results show that the technique offered by each of the same techniques works better. It can find the optimal solution at a shorter time.

Li et al. (2013) presented a method to solve NP-hard problems using the effectual hybrid genetic simulated annealing algorithm (HGSAA). Location of facilities, vehicle route projecting and inventory control are highly pertinent and important issues in designing an organization system for e-business. Some recyclables have no major drawbacks inbeing able to re-enter the product sales stream after a typical rebuilding process. By focusing on the problem in the regular e-shopping system, they produced a problem-free routing model. The results of the computational processes for numerical examples show that HGSAA has better efficiency during computing the computational stability of the acceptable solution of the GA technique. The model presented is highly effective in helping managers make large-scale decisions in a supply chain environment. However, some plans and items should be considered in management. In general, decision-makers are always involved in perverse problems. There are many uncertainties that need to be regarded in decision-making, and the fuzzy set theory with a long history is used for this purpose. Given the fuzzy demand or associated fuzzy costs, the LIRP model is assumed to yield the desired result.

Kanagaraj et al. (2013) presented a newly developed meta-heuristic optimization algorithm by the Coco search. CS has been suggested with the known genetic algorithm (GA), determined CS-GA, to solve the problem of assigning validity and overtime. In recent studies, due to the high capability and redistribution of meta-discoveries, the use of these methods to solve problems has increased dramatically. By integrating genetic operators into the CS method, the balance between exploration and exploitation capabilities is increased, and the search space is searched during the performance of the algorithm. The calculations performed on a number of classical reliability-redundancy allocation issues from the literature confirm the validity of the proposed technique. The experimental results are reviewed with some of the best solutions. The results of these comparisons too their evolutionary algorithms show that the proposed CS-GA algorithm is useful in finding optimal solutions. The elitist strategy used in CS-GA also ensures that the best answers are usually passed down to future generations. This method has to be developed owing to its relatively large computations despite the optimum performance in achieving the optimal solution.

Karaoglan and Altiparmak (2010) tackled one of the important issues of the distribution network. Designing materials distribution networks is one of the most important issues of supply chain management, maintenance and logistics. The main elements in designing a distribution network are location and routing decisions. Since these elements are also dependent on many distribution networks, overall system costs can be minimized by simultaneously resolving their location and route decisions. LRPSPD identifies storage locations or warehouses, designs the route of the vehicle to meet customers' delivery needs with a vehicle, and minimizes the overall cost of this shift. To demonstrate the effectiveness of the proposed system, they performed an experimental study and compared their results to the optimal responses obtained by the MIP formula obtained from samples derived from recent studies. The results of the computation of the samples show that the proposed method is able to find optimal solutions at the right time, and high quality solutions (0.18% and 0.61% mean gap) with algorithm suggestion are obtained at the time of rational calculation.

Mousavi et al. (2013) presented a new mathematical procedure for the capacitated multi-facility location–allocation issue with probabilistic end users' locations and demands. The procedure is formularized into the frameworks of the envisaged value model (EVM) and the chance-constrained programming (CCP) based on two various distance measures. To dissolve the model, two hybrid rational algorithms are proposed, where the accidental simulation and simplex algorithm are the bases for both algorithms. In general, in the first method algorithm, called SSGA, a special type of genetic algorithm is combined, and in the second method, SSVDO, a vibration-damping (VDO) method is employed together. Given the complexity of the issues in this area, two hybrid intelligent methods, SSGA and SSVDO based on GA and VDO, respectively, have been integrated and combined with simplex and random simulation, respectively. To produce optimal solutions and better convergence, the Taguchi method is used to adjust the control parameters of each binocular and its corresponding algorithm. Not only does SSVDO perform better than SSGA for the Euclidean CCP model, but it also performs well for both Euclidean CCP and EVM models.

Nadizadeh and Nasab (2014) introduced the dynamic capacitated location-routing problem with fuzzy demands (DCLRP-FD). In the DCLRP-FD model, the problem of locating vehicle navigation facilities and issues in a time horizon can be solved. The location of the facility is only possible during the first planning period. But the decision on routing may vary at times and sometimes. In addition, as warehouses and vehicles have a predetermined and predetermined capacity to deliver customer service, demand changes over time. Therefore, a constrained programming formula of the fuzzy opportunity is presented to solve this problem, a hybrid heuristic algorithm (HHA) with several steps, including general search, random simulation and a local search method. Moreover, the capability of HHA is demonstrated by measuring with the lower bound of solutions and using a standard benchmark set of test problems. Numerical examples show that the proposed method has acceptable efficiency and can be used in real-world affairs. More thorough research can be as follows: (a) Determining a model meeting the system requirements. (B) Creating a model based on more realistic assumptions.

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Teo and Ponnambalam (2008) introduced a hybrid ACO/ PSO heuristic to solve the sporadic row layout problem. As opposed to common researches, the clearances and size of machines are treated as variables using the non-linear 0-1 mathematical model adopted from the literature. In this research, the dimensions and clearance between machines as a variable were considered, which most of earlier researchers ignored them. This model results in a more realistic representation of the problem. Different sets of issues are used to evaluate the proposed ACO /

PSO. The results of the computational methods for the numerical examples presented show that this method combines computation and achieves optimal results with feasible performance. The proposed model is highly helpful for managers to make appropriate decisions. However, due to some of the items and parameters in practical problems, it needs to be developed in spite of its optimal performance.

(Zekavatmand et al., 2023) have proposed a stochastic version of the location-routing problem (SLRP) in which both the cost of transport and the number and speed of the vehicle are chosen randomly. A hybrid solution method based on ACO and DES is proposed. After applying a sequential heuristic algorithm to solve the location allocation problem, the ACO is used to solve the travel-related routing. They used a sequential approximation algorithm to solve the random positioning and routing problem (SLRP) (they proposed a new hybrid algorithm to solve the random positioning and then routing). The proposed method uses the ACO algorithm to solve the sequencing problem to refer customers to the distribution network. Then, the routing solution is used as input. This algorithm provides answers to real problems. Although it is also used to calculate costs, the process increases the computation time.

(Qiu et al., 2024) have introduced a hybridization of genetic method and gradually increasing probability for the application of the neighborhood search procedure on the best individuals as the number of iterations of the genetic algorithms increases. They implemented the proposed hybrid algorithms and compared their performance to several recently proposed hybrid methods. On the contrary, it uses the neighborhood search method for all the people surveyed, the two hybrid algorithms apply simulated annealing to the best person in the population in each iteration. They presented algorithms for them called terminal location problem models with fuzzy values. To investigate the effectiveness of the proposed algorithms, they implemented and solved fuzzy terminal location problem models. It is assumed that the fuzzy model has a fuzzy number of passengers proportional to the hypothesis as well as fuzzy neighborhoods with predetermined upper and lower boundaries for the number of positions required. They randomly generated algorithms on various terminal locations with large-scale fuzzy values where the cost function coefficient is assumed as the fuzzy value. Although the proposed method, it has many iterations, it is suitable for real-time problems.

Esmaeeli et al., 2025) investigated one of the real routing and location issues. In their approach, using the complex return paths (CLRPMB), the problem design is addressed. CLRPMB seeks to minimize system costs by finding parking spaces and designing car routes on such demand for delivery and how each customer is tracked by the same vehicle. Since CLRPMB is a difficult NP problem, they propose a special algorithm to solve the problem. To evaluate the performance of the proposed technique, they conduct an extensive study and compare their results with those obtained for similar problems.

- They consider the capacitated location-routing difficulty with mixed backhauls.
- They propose a memetic algorithm based on simulated annealing and genetic and programming formulation.

- The Memetic algorithm offers reasonable or optimal solutions over an acceptable period.

(Sahebi et al., 2024) presented a memetic algorithm (MA) to solve the Indifference single allotment hub location problem (USAHLP). Two impressive local search heuristics are designed and executed in the form of an evolutionary algorithm to improve the position and allocation of a part of the problem. They have designed the MA-magnet to solve USAHLP. The evolutionary part of the MA uses binary encryption, good tournament selection, two dots, and jumps with frozen bits. An important feature of the proposed MA is its new and efficient local search. Its limitations are included in the evolutionary algorithm framework. The first attempt is to find the best hubs, while the second is to improve the allocation of source nodes / nodes to the hubs, when a set of poles is already inserted. The empirical studies presented demonstrate the reliability, good performance, and feasibility of MA. The MA method is highly effective to obtain known solutions in small and medium-sized CAB and AP cases. This method works well for small to medium problems, but it is not suitable for large problems.

4.1.2. Summary of the reviewed Hybridization of meta heuristic algorithms based techniques

In the previous sub-section, 22 selected HA algorithms for location routing problem were analyzed, and their advantages and disadvantages were discussed. Table 3 shows the comparison of the most important advantages and disadvantages of each article.

Table 3. A side-by-side comparison of the most important advantages and disadvantages of the Hybridization of meta heuristic algorithms for location problem

Paper	Advantage	Disadvantage
Escobar et al. (2013)	• Low computing • Using real values • Comparability	• Having some limitations • Applying medium graphs
Pichka et al. (2018)	• Generate synchronous version • Improve average cost	• Applying medium graphs
Marić et al. (2012)	• Comparison of algorithms	• Applying medium graphs
Martínez-Salazar et al. (2014)	• Comparing with other algorithms • Low computing time • Improving the quality of the answers	• Having some limitations
Nekooghadirli et al. (2014)	• Uncertainty Parameters • Average and proper distance • Computation time	• Need to develop method
Rajagopalan et al. (2007)	• Provide high quality answer • Best solution with minimal time	• Need for further study in the future
Tam et al. (2019)	• Reduction in costs • Suitable for great problems • Good run time	• Variable Limit
	• Minimizing total cost	• Suitable for small scale issues

Sörensen et al. (2012)	• Short computing time • Applicable to the business environment	• Approximate answers
Wang et al. (2005)	• Computing quickly the best parameters • Improving the solution and reduce the execution time • Improve its average cost • Low runtime	• Applying medium graphs • Need improve current method
Qiu et al. (2009)	• Development of GA-PSO algorithms • Improves the best known upper bounds • More competitive with the algorithms • Improve the performances in both algorithm	• Need improve current method • High dependence to parameters
Cong and Zhuang (2002)	• Better than TDOA when the AOA measurement is accurate • Verifying the (good) performance of the basic extraction method	• High number of iterations • High runtime
Cabrera G et al. (2012)	• Get the right answer in a short time • Big scale optimization • Comparability • No need for extensive computing resources	• Need to develop method
Li et al. (2013)	• Real-world application • Better time calculation • Optimal solution and higher computing stability	• The development of the method in the future • Check out more problems in the future
Kanagaraj et al. (2013)	• Very effective • Effective in finding the perfect solution	• Lot of calculations
Karaoglan and Altiparmak (2010)	• Ideal or very good solution • Logical calculation time	• Exploring the algorithm for future big problems
Mousavi et al. (2013)	• Better performance • Better convergence	• Reading more in the future • Checking for bigger problems
Nadizadeh and Nasab (2014)	• Real-world application • Provide Strong Algorithm	• Future review needs • Future development under the assumption of realism
Teo and Ponnambalam (2008)	• Comparability • Verifying the (good) performance of the basic extraction method	• Parameter Limit
(Zekavatmand et al., 2023)	• Comparability • Cost Estimation • Close to real answers	• Development of the method in the future • Lot of calculations

(Qiu et al., 2024)	• Real-world application • Low computing time • It works for great issues	• Repeated algorithms
(Esmaeeli et al., 2025)	• Low run time • Run on large scales • High quality solutions	• High iterations • Need to develop method
(Sahebi et al., 2024)	• Improve the quality and time of the CPU • Solving the two problems at the same time • Application for large samples	• Need to develop method • Many repetitions

5. Limitation

This study was designed to lead a systematic review as rigorously as possible, but there may be some limitations. Hence, in this study, the limitations outlined below should be considered by future studies:

Research scope: The location problem was coverage in different sources such as academic publications, editorial notes, technical reports and web pages. Particularly, the researchers eliminated articles published in national journals and conferences. Additionally, the researchers eliminated the articles that were not about location problem. Therefore, in the competency of this review, it must be regarded that this systematic review considered studies published in the major international journals.

Study and publication: The researchers chose Google scholar as a dependable electronic database. Based on the existing statistics, this electronic database would suggest the most related and valid studies. However, it could not be guaranteed that all selected studies are applicable. There is a probability that some applicable studies overlooked the proceeding of article selection mentioned in Section 3. May be some applicable articles go unnoticed because of different reasons that these reasons can limit from the searching of wrong keywords to the data extraction.

6. Open issue

This section presents the main location problem techniques that have not been extensively and comprehensively studied yet; this can be research guidance for future studies. Considering the meta-heuristic techniques, the problem of location problem and the criteria mentioned in this article is like competitive, iteration number, and runtime, while some completely disregard these issues. For example in Díaz et al. (2017), it is necessary to consider convergence, iteration number, runtime and improving algorithms. Also, some techniques consider competitive, Comparable, success, while some completely disregard these issues. For example, in Lai et al. (2016) , it is great to consider considering competitive, Comparable, success. Therefore, by converting and analyzing the referred meta-heuristic techniques, there is no independent technique addressing all issues included in the location problem. Another attractive point of future study could be investigation of solving the location problem by meta-heuristic algorithms. In addition, some meta-heuristic algorithms that are more efficient on these issues are considered. Their review will be interesting. When the size of location problem increases, it is clear that the runtime and the number of repetitions of the algorithm increase. To avoid these difficulties, meta-heuristic algorithms should be designed aiming at eliminating the difficulties caused by such cases. Furthermore, the efficiency of meta-heuristic algorithms in solving the location problem is one of the important factors, including in large-scale problems. Therefore, the efficiency of the algorithm for global optimal solutions, the number of success and convergence, are good and interesting criteria for future studies.

In the most of the reviewed techniques, many new meta-heuristic algorithms such as simulated annealing optimization, artificial fish optimization algorithm, and cat swarm optimization with the balancing aim were not applied to this problem, especially in trusted and prestigious journals. Additionally, some factors such as large-scale graph, the dependence of algorithms on parameters, decreasing solutions space, starts with random non-feasible solutions, global best position and standard deviations were not considered. Moreover, the paper widely reviews the application of meta-heuristic algorithms in the location problem. By reviewing the papers, we observed that the results of combined meta-heuristic algorithms were better than those of innovative algorithms; in other words, most of the criteria improve with the proposed hybrid algorithms; therefore, some new hybrid approaches are needed in the future.

7. Conclusion

Location navigation problems can have different effects on the economy of the community. Although meta-heuristic algorithms are applicable methods for solving location problems, due to computational time and more iterations, in recent years the desire to combine these methods has been suggested to increase their efficiency. Therefore, we propose combined meta-discovery to solve these kinds of problems. These methods give the best results and work best on the same set of problems at the same time. Again, the calculations show that: Meta-hybrid results are better than heuristic and meta-cognitive combinations. As its creation mechanism to create new solutions, it allows for the storage and use of relatively large equations of good and diverse solutions throughout the search process. These methods require a minimum of computation time and are very suitable in line with similar experiments presented in the literature. In general, combined meta-cognitive methods are a very effective tool for finding suitable solutions. Case studies illustrate the approaches needed for social learning research, as long-term process analysis requires sensitivity to social and economic contexts. Therefore, fuzzy data can be used to solve the problem in obtaining a dataset of real problems. This could also be the subject of future research.

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