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Survey

The vehicle routing problem: State of the art classification and review

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ABSTRACT

Over the past decades, the Vehicle Routing Problem (VRP) and its variants have grown ever more popular in the academic literature. Yet, the problem characteristics and assumptions vary widely and few literature reviews have made an effort to classify the existing articles accordingly. In this article, we present a taxonomic review of the VRP literature published between 2009 and June 2015. Based on an adapted version of an existing comprehensive taxonomy, we classify 277 articles and analyze the trends in the VRP literature. This classification is the first to categorize the articles to this level of detail.

1. Introduction

Dantzig and Ramser (1959) were the first to introduce the "Truck Dispatching Problem", modeling how a fleet of homogeneous trucks could serve the demand for oil of a number of gas stations from a central hub and with a minimum traveled distance. Five years later, Clarke and Wright (1964) generalized this problem to a linear optimization problem that is commonly encountered in the domain of logistics and transport: i.e., how to serve a set of customers, geographically dispersed around the central depot, using a fleet of trucks with varying capacities. This became known as the 'Vehicle Routing Problem' (VRP), one of the most widely studied topics in the field of Operations Research.

Current VRP models, however, are immensely different from the one introduced by Dantzig and Ramser (1959) and Clarke and Wright (1964), as they increasingly aim to incorporate real-life complexities, such as time-dependent travel times (reflecting traffic congestion), time windows for pickup and delivery, and input information (e.g., demand information) that changes dynamically over time. These features bring along substantial complexity. As the VRP is an NP-hard problem (Lenstra & Rinnooy Kan, 1981), exact algorithms are only efficient for small problem instances. Heuristics and metaheuristics are often more suitable for practical applications, because real-life problems are considerably larger in scale (e.g., a company may need to supply thousands of customers from dozens of depots with numerous vehicles and subject to a variety of constraints).

The number of solution methods introduced in the academic literature (for old as well as new variants of the VRP) has grown rapidly over the past decades. Moreover, the processing speed and memory capacity of current computers has increased exponentially, enabling to solve larger instances of the VRP which spurs the progression in the research field and the development of commercial software for the VRP. Nowadays VRP software is being used by thousands of companies, among others Coca-Cola Enterprises and Anheuser-Busch Inbev, in a large variety of industry sectors (Drexl, 2012a; Partyka & Hall, 2014).

The study by Eksioglu, Vural, and Reisman (2009) revealed 1021 journal articles with VRP as the main topic, published between 1959 and 2008. A number of books (e.g. Golden, Raghavan, &

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Wasil, 2008; Toth & Vigo, 2002, 2014) and a considerable amount of proceedings have also contributed to the VRP literature that exists today. According to Eksioglu et al. (2009), the VRP literature has been growing exponentially at a rate of 6% each year. This popularity makes it difficult to keep track of the developments in the field, and to have a clear overview of which variants and solution methods are relatively novel. Furthermore, taxonomies on vehicle routing are rather scarce (Eksioglu et al., 2009; Lahyani, Khemakhem, & Semet, 2015), while surveys/reviews of existing literature often only focus on specific variants or aspects of the VRP, e.g. the capacitated VRP (Laporte, 2009), periodic VRPs (Campbell & Wilson, 2014), the VRP with time windows (Bräysy & Gendreau, 2005a, 2005b; Gendreau & Tarantilis, 2010), dynamic VRPs (Pillac, Gendreau, Guéret, & Medaglia, 2013), pickup and delivery problems (Berbeglia, Cordeau, Gribkovskaia, & Laporte, 2007), vehicle routing with multiple depots (Montoya-Torres, Lopez France, Nieto Isaza, Felizzola Jimenez, & Herazo-Padilla, 2015), vehicle routing with split deliveries (Archetti & Speranza, 2012), green vehicle routing (Lin, Choy, Ho, Chung, & Lam, 2014) and synchronization aspects in vehicle routing (Drexl, 2012b). Additionally, these surveys often focus on reviewing the proposed solution methods, rather than identifying differences in assumptions and characteristics between VRP variants. For example, a categorized bibliography on metaheuristic approaches for different VRP variants is available in Gendreau, Potvin, Bräysy, Hasle, and Lokketangen (2008).

The purpose of this article is to classify the academic literature on the VRP, based on the detailed characteristics of the VRP problem studied. As we base our classification on the taxonomy by Eksioglu et al. (2009), we restrict our analysis to articles published between 2009 and June 2015 and as such, do not intend to provide an exhaustive overview of the VRP literature. To the best of our knowledge, this article provides the first structured classification of recent VRP literature. The main contribution of our paper is the resulting classification table which is made available online as Supplementary material. This classification table enables future researchers to easily find relevant literature by eliminating or selecting characteristics in the taxonomy, leaving only articles tailored to their interests. Additionally, the classification table allows to analyze which characteristics and VRP variants are most popular, and which are promising topics for future research.

Section 2 defines the scope of the survey, and Section 3 introduces general notations for popular VRP variants. The proposed adaptations to the taxonomy of Eksioglu et al. (2009) are discussed in Section 4. In Section 5, an analysis of the classification results is presented. We highlight our findings and discuss a number of relatively novel topics (i.e., the Open VRP, the Dynamic VRP and the Time-dependent VRP) in further detail. Section 6 provides conclusions and avenues for future research.

2. Scope of the survey

We structure the recent literature, published between 2009 and mid-2015, using a taxonomic framework. The classification is followed by a survey that uses the taxonomy to evaluate the trends in the field, and to identify which articles contribute to these trends.

We restricted the reviewed literature as follows. Only relevant articles published in English-language journals are considered, i.e., books, conference proceedings and dissertations are excluded. To extract the most relevant literature and keep the number of articles manageable, the following search strategy was applied. First, only articles containing "vehicle routing" as a title word were selected. The search was limited to articles published in journals with an Impact Factor of at least 1.5 in the domains of Operations Research & Management Science, Transportation or Transportation Science & Technology (based on the Impact Factors of 2013 by Thomson Reuters). Articles published in Computers & Industrial Engineering (not in one of these categories) are included as well because of their relevance. Second, this set of articles was extended with highly cited articles published in any ranked journal. Articles were selected if they contain "vehicle routing" in the title or as a keyword, and they were cited at least five times per year, on average, since the year of publication. Third, the abstracts of the resulting articles were read to determine their relevance to the subject. Since the VRP already is an extensive research domain, the decision was made not to include any combined problems, such as inventory routing problems (see Bertazzi, Savelsbergh, & Speranza, 2008; Coelho, Cordeau, & Laporte, 2014), location-routing problems (see Prodhon & Prins, 2014), problems combining routing decisions with scheduling decisions related to other activities such as machine or production scheduling (see Chen, Hsueh, & Chang, 2009; Ullrich, 2013), multi-echelon routing (see Baldacci, Mingozzi, Roberti, & Calvo, 2013; Hemmelmayr, Cordeau, & Crainic, 2012), and routing with cross-docking (see Liao, Lin, & Shih, 2010). Some papers take into account vehicle loading constraints which are more sophisticated than the traditional capacity constraints or simple precedence constraints appearing in e.g., the Vehicle Routing Problem with Pickup and Delivery (VRPPD, see Section 4). These papers are excluded as well since, in our opinion, they combine two separate, well-established and well-studied problems, i.e., vehicle routing problems and container loading problems. For a recent survey on the integration of both problems, we refer to Pollaris, Braekers, Caris, Janssens, and Limbourg (2015).

This search strategy resulted in a final set of 277 articles which, while not exhaustive, contains the majority of recent articles on VRP and in our opinion can be considered as representative for the field. An overview per journal is given in Table 1 (Appendix A provides an overview of the selected references according to publication year). Table 1 shows that European Journal of Operational Research, Computers & Operations Research, and Expert Systems with Applications published most of the surveyed articles.

3. Terminology and notations

The classical VRP, also known as the Capacitated VRP (CVRP), designs optimal delivery routes where each vehicle only travels one route, each vehicle has the same characteristics and there is only one central depot. The goal of the VRP is to find a set of least-cost vehicle routes such that each customer is visited exactly once by one vehicle, each vehicle starts and ends its route at the depot, and the capacity of the vehicles is not exceeded.

This classical VRP has been extended in many ways by introducing additional real-life aspects or characteristics, resulting in a large number of variants of the VRP. It is possible to extend this problem by varying the capacities, which results in the Heterogeneous Fleet VRP (HFVRP), also known as the Mixed Fleet VRP. Another popular extension, the VRP with Time Windows (VRPTW), assumes that deliveries to a given customer must occur in a certain time interval, which varies from customer to customer.

In the VRP with Pickup and Delivery (VRPPD), goods need to be picked up from a certain location and dropped off at their destination. The pick-up and drop-off must be done by the same vehicle, which is why the pick-up location and drop-off location must be included in the same route (Tasan & Gen, 2012). A related problem is the VRP with backhauls (VRPB), where a vehicle does deliveries as well as pick-ups in one route (Pradenas, Oportus, & Parada, 2013). Some customers require deliveries (referred to as linehauls) and others require pick-ups (referred to as backhauls). The combination of linehauls and backhauls has been proven very valuable to

Table 1
Overview of the number of selected articles per journal.

Journal	2013 impact factor	Number of selected articles
Transportation Research Part B: Methodological	3.894	3
Omega: The International Journal of Management Science	3.190	3
Transportation Research Part C: Emerging Technologies	2.820	9
Applied Soft Computing	2.679	3
International Journal of Production Economics	2.393	1
Transportation Science	2.294	21
Transportation Research Part E: Logistics and Transportation Review	2.193	21
Applied Mathematical Modeling	2.150	1
Decision Support Systems	2.036	4
Neurocomputing	2.005	1
Mathematical Programming	1.984	1
Expert Systems with Applications	1.965	38
Engineering Applications of Artificial Intelligence	1.962	2
Journal of Advanced Transportation	1.878	1
European Journal of Operational Research	1.843	65
Networks and Spatial Economics	1.803	2
Production and Operations Management	1.759	1
Computers & Operations Research	1.718	62
Computers & Industrial Engineering	1.690	18
Transportation Research Part D: Transport and Environment	1.626	3
International Journal of Systems Science	1.579	1
European Journal of Industrial Engineering	1.500	1
Operations Research	1.500	7
Manufacturing & Service Operations Management	1.450	1
Journal of Heuristics	1.359	1
Annals of Operations Research	1.103	1
Journal of the Operational Research Society	0.911	1
Networks	0.739	1
Discrete Applied Mathematics	0.677	1
Simulation – Transactions of The Society for Modeling and Simulation International	0.656	1
International Transactions in Operational Research	0.481	1

the industry. The well-known 'milk run' concept is derived from the successes reached with VRPB: by employing milk runs, transportation costs and total distance traveled can be decreased significantly and the vehicle loading rate increases (Brar & Saini, 2011).

The Multi-Depot VRP (MDVRP) assumes that multiple depots are geographically spread among the customers (Montoya-Torres et al., 2015). The Periodic VRP (PVRP) is used when planning is made over a certain period and deliveries to the customer can be made in different days (Campbell & Wilson, 2014; Gulczynski, Golden, & Wasil, 2011b). For the PVRP, customers can be visited more than once, though often with limited frequency.

Recently, some of these variants have been combined into so-called "rich" vehicle routing problems, simultaneously including multiple real-life aspects (see Lahyani, Khemakhem, et al. (2015) for a recent discussion and survey).

4. Taxonomy

The applied taxonomy is an adapted version of the taxonomy proposed by Eksioglu et al. (2009). Five main characteristics are distinguished (type of study, scenario characteristics, problem physical characteristics, information characteristics and data characteristics), each with its own detailed categories and subcategories (see Table 2). The (sub)categories indicated in bold are adapted from Eksioglu et al. (2009). These adaptations are discussed in the following paragraphs.

With respect to the applied methods (category 1.2), we propose to differentiate between classical heuristics and metaheuristics. Laporte (2009) defines classical heuristics as heuristics that do not allow the intermediate solution to deteriorate during the process of finding better (optimal) solutions. As a result, they often get trapped in local optima. Examples include construction heuristics such as the savings algorithm (Clarke & Wright, 1964), and improvement heuristics such as the λ-opt mechanism (Lin, 1965). Metaheuristics, on the other hand, include mechanisms that avoid getting trapped in local optima. Examples are Tabu Search (Glover, 1986) and Simulated Annealing (Kirkpatrick, Gelatt, & Vecchi, 1983).

Onsite service or waiting times (category 2.5) indicate the exact time a vehicle has to wait at a customer before it can start the service or the amount of time it takes to perform the service. This is particularly relevant when dealing with time windows. In this category, we made an adaptation to the taxonomy provided by Eksioglu et al. (2009) by merging the two subcategories 'time dependent' and 'vehicle type dependent' into one subcategory 'dependent', as the service time can be dependent on many more aspects (such as the number of personnel in the vehicle (Pureza, Morabito, & Reimann, 2012), or the delivery quantity (Salani & Vacca, 2011)).

The time window type (category 3.5) classifies articles depending on the party that is restricted by the window (either customers, depots or drivers). Eksioglu et al. (2009) also included a time window restriction on roads. Since this is rare, it is excluded in this paper. Additionally, as it is often unclear which type of instances (randomly dispersed customers, clustered customers, or a combination of these) are used to test proposed solutions methods, we decided to remove category 'geographical location' from the taxonomy on problem physical characteristics as well.

VRP articles may also be classified according to the number of the vehicles available. Eksioglu et al. (2009) consider three categories based on the number of vehicles to be used: exactly n vehicles, up to n vehicles, and an unlimited amount of vehicles. However, situations in which exactly n vehicles should be used are rather uncommon, except for the single vehicle case (in a multi-vehicle context, typically the option exists not to use some vehicles when this is beneficial). Therefore, we adapt category 3.6.1 to indicate articles on single vehicle problems only ($n = 1$). In case of multiple vehicles, either a limited or an unlimited amount may be available (categories 3.6.2 and 3.6.3, respectively). Note that the single vehicle case is commonly referred to as the Traveling Salesman Problem (TSP), for which in itself an extensive amount of literature is available (see e.g., Applegate, Bixby, Chvatal, & Cook, 2011; Gutin & Punnen, 2007; Lawler, Lenstra, Rinnooy Kan, & Shmoys, 1985). In this paper, it is not our intention to review the complete TSP literature; rather, we focus on the VRP. Hence, most of the reviewed articles address multi-vehicle problems.

Finally, in category 3.10, articles are categorized according to the selected objective function (either focusing on travel time, distance, number of vehicles, costs related to lateness, costs related to risks or hazards, any other objective type, or a combination of these). Compared to the original classification, the subcategory 'other' was added since several authors take into account objectives which are specific to the problem under study.

5. Results of the classification

In this section, the results of the classification are discussed. The detailed classification results of the 277 articles are shown in the electronic Appendix of this manuscript. The .xlsx format allows the user (e.g., future researchers) to select any given combination

Table 2
The proposed taxonomy (adapted from Eksioglu et al. (2009)).

1. Type of study
  1.1. Theory
  1.2. Applied methods
    1.2.1. Exact methods
    1.2.2. Classical Heuristics
    1.2.3. **Metaheuristics**
    1.2.4. Simulation
    1.2.5. Real-time solution methods
  1.3. Implementation documented
  1.4. Survey, review or meta-research
2. Scenario Characteristics
  2.1. Number of stops on route
    2.1.1. Known (deterministic)
    2.1.2. Partially known, partially probabilistic
  2.2. Load splitting constraint
    2.2.1. Splitting allowed
    2.2.2. Splitting not allowed
  2.3. Customer service demand quantity
    2.3.1. Deterministic
    2.3.2. Stochastic
    2.3.3. Unknown
  2.4. Request times of new customers
    2.4.1. Deterministic
    2.4.2. Stochastic
    2.4.3. Unknown
  2.5. Onsite service/waiting times
    2.5.1. Deterministic
    2.5.2. Dependent
    2.5.3. Stochastic
    2.5.4. Unknown
  2.6. Time window structure
    2.6.1. Soft time windows
    2.6.2. Strict time windows
    2.6.3. Mix of both
  2.7. Time horizon
    2.7.1. Single period
    2.7.2. Multi-period
  2.8. Backhauls
    2.8.1. Nodes request simultaneous pickups and deliveries
    2.8.2. Nodes request either linehaul or backhaul service, but not both
  2.9. Node/Arc covering constraints
    2.9.1. Precedence and coupling constraints
    2.9.2. Subset covering constraints
    2.9.3. Recourse allowed
3. Problem Physical Characteristics
  3.1. Transportation network design
    3.1.1. Directed network
    3.1.2. Undirected network
  3.2. Location of addresses (customers)
    3.2.1. Customer on nodes
    3.2.2. Arc routing instances
  3.3. Number of points of origin
    3.3.1. Single origin
    3.3.2. Multiple origin
  3.4. Number of points of loading/unloading facilities (depot)
    3.4.1. Single depot
    3.4.2. Multiple depots
  3.5. Time window type
    3.5.1. Restriction on customers
    3.5.2. Restriction on depot/hubs
    3.5.3. Restriction on drivers/vehicle
  3.6. Number of vehicles
    3.6.1. Single vehicle
    3.6.2. Limited number of vehicles
    3.6.3. Unlimited number of vehicles
  3.7. Capacity consideration
    3.7.1. Capacitated vehicles
    3.7.2. Uncapacitated vehicles
  3.8. Vehicle homogeneity (Capacity)
    3.8.1. Similar vehicles
    3.8.2. Load-specific vehicles
    3.8.3. Heterogeneous vehicles
    3.8.4. Customer-specific vehicles
  3.9. Travel time
    3.9.1. Deterministic
    3.9.2. Function dependent (a function of current time)
    3.9.3. Stochastic
    3.9.4. Unknown
  3.10. Objective
    3.10.1. Travel time dependent
    3.10.2. Distance dependent
    3.10.3. Vehicle dependent
    3.10.4. Function of lateness
    3.10.5. Implied hazard/risk related
    3.10.6. Other
4. Information Characteristics
  4.1. Evolution of information
    4.1.1. Static
    4.1.2. Partially dynamic
  4.2. Quality of information
    4.2.1. Known (Deterministic)
    4.2.2. Stochastic
    4.2.3. Forecast
    4.2.4. Unknown (Real-time)
  4.3. Availability of information
    4.3.1. Local
    4.3.2. Global
  4.4. Processing of information
    4.4.1. Centralized
    4.4.2. Decentralized
5. Data Characteristics
  5.1. Data used
    5.1.1. Real-world data
    5.1.2. Synthetic data
    5.1.3. Both real and synthetic data
  5.2. No data used

of identifiers in order to retrieve the relevant articles. Moreover, the classification results may be used to analyze which characteristics and VRP variants are most popular, and which topics remain relatively underexamined. Note that some papers appear multiple times in this classification as they consider several VRP variants. As a result, the classification table contains 327 lines. In the remainder of this section we discuss our main findings (all percentages are calculated using this total of 327).

In Section 5.1, results are analyzed on the level of individual characteristics. Observations on combinations of characteristics are discussed in Section 5.2. Finally, in Section 5.3, we provide a more detailed discussion of three specific problem variants which have been studied extensively in recent years.

5.1. Individual characteristics

Only a limited number of papers have a main focus on theory (category 1.1, 7.01%) or on reviewing existing literature (category 1.4, 3.66%). In the majority of papers (95.12%), at least one type of solution method is proposed or applied. An overview of these solution methods (category 1.2) is presented in Table 3. Next to the relative presence of a type of method over all reviewed articles, also the relative presence per publication year is shown. This may help to identify trends. However, it is hard to make strong statements due to the relatively short review period and the often limited number of papers per characteristic per publication year.

Table 3 indicates that metaheuristics are, by far, used most often. Exact methods and classical heuristics are applied less often (probably due to the fact that the former is computationally expensive for complex and large instances, while the latter can get stuck in local optima). Simulation and real-time solution methods are rarely used. Given their importance in solving realistic VRPs, the further development of metaheuristic methods provides an opportunity for further research.

Table 4 gives an overview of the scenario and problem physical characteristics, extending the basic uncapacitated VRP, that have been considered most often in the reviewed articles. Again, percentages per publication year are presented as well. Clearly, most

Table 3
Overview of applied methods in absolute and relative numbers.

Applied method (1.2)	Number of models	Relative presence							
		Overall (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)
Metaheuristic (1.2.3)	233	71.25	65%	63	65	77	80	76	65
Exact Method (1.2.1)	56	17.13	17	20	26	10	13	17	19
Classical Heuristic (1.2.2)	32	9.79	11	15	15	17	4	5	10
Real-time solution methods (1.2.5)	11	3.36	6	0	6	4	5	2	0
Simulation (1.2.4)	7	2.14	4	4	6	0	2	0	0

Table 4
Overview of considered characteristics in absolute and relative numbers.

Characteristic	Number of models	Relative presence							
		Overall (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)
Capacitated vehicles (3.7.1)	296	90.52	91	96	91	85	88	94	87
Heterogeneous vehicles (3.8.3)	54	16.51	30	11	15	13	27	9	10
Time windows (2.6)	124	37.92	28	41	44	42	43	39	23
Backhauls (2.8)	61	18.65	17	22	15	10	21	11	45
Multiple depots (3.4.2)	36	11.01	4	4	15	13	11	14	19
Recourse allowed (2.9.3)	31	9.48	7	13	15	8	5	14	3
Multi-period time horizon (2.7.2)	29	8.87	4	11	9	13	9	6	13
Precedence and coupling constraints (2.9.1)	28	8.56	7	11	6	8	13	6	10
Subset covering constraints (2.9.2)	28	8.56	2	11	12	6	9	11	10
Split deliveries allowed (2.2.1)	20	6.12	4	9	9	0	5	5	16
Stochastic demands (2.3.2)	20	6.12	4	7	12	8	5	5	3
Unknown demands (2.3.3)	6	1.83	2	2	0	2	4	2	0
Time-dependent travel times (3.9.2)	10	3.06	2	4	6	6	2	2	0
Stochastic travel times (3.9.3)	9	2.75	0	2	0	2	7	5	0
Unknown travel times (3.9.4)	5	1.53	2	0	6	0	2	2	0
Dynamic requests (2.4)	8	2.45	2	2	3	4	4	0	0

articles consider capacitated vehicles. Vehicles are rarely assumed uncapacitated, except in cases where one unit of demand is considered negligible in size (e.g., Ferrucci, Bock, & Gendreau, 2013). Moreover, vehicles are generally assumed to be identical. Load-specific or customer-specific vehicle types are not popular in recent literature (respectively 1.53% and 4.28%), although some authors have considered VRPs with multiple compartments (e.g., Lahyani, Coelho, Khemakhem, Laporte, & Semet, 2015; Mendoza, Castanier, Guéret, Medaglia, & Velasco, 2010, 2011). Time windows are considered in 37.92% of the articles. Most often these time windows are assumed to be strict (30.58%). Soft time windows have been considered as well (5.81%), while a mix of soft and strict time windows is rare (1.53%). These time windows are generally imposed on the visit time at customers (34.86%), while restrictions on depots and vehicles/drivers are considered less frequently (13.76% and 12.23%, respectively). Backhaul customers are considered in 18.65% of the articles, with almost even shares for the cases of nodes requesting simultaneous pickups and deliveries and nodes requesting either pickups or deliveries. Multiple depots are considered in 11.01% of the articles, while the different types of node covering constraints (category 2.9) appear in a slightly less than 10% of the articles. Other characteristics, such as multiple periods and splitting of requests, also appear in less than 10% of the surveyed articles.

A wide variety of objective functions is used in VRP literature, as is shown by the fact that almost one out of five articles (18.35%) considers a non-standard objective (category '3.10.6 Other'). The Cumulative VRP, for example, minimizes the sum of the arrival times at the customers (Ke & Feng, 2013; Lysgaard & Wøhlk, 2014; Mattos Ribeiro & Laporte, 2012; Ngueveu, Prins, & Wolfler Calvo, 2010). However, almost all articles include a routing cost (either based on distance or travel time) in the objective function (92.35%), while vehicle dependent costs are relatively common as well (38.23%).

With respect to information and data characteristics, problems with dynamic information (category 4.1.2) are modeled in 4.28% of the articles. Although the quality of information (category 4.2) is typically assumed to be deterministic in VRP literature (82.57%), several authors consider problems with stochastic or unknown (real-time) information (9.17% and 4.59%, respectively). Additionally, information is generally assumed to be available globally (89.30%) and processed centrally (96.64%). Finally, most authors use artificial data to test their solution methods (84.10%). Real-life data, or a combination of artificial and real-life data, are both used in 6.12% of the articles.

In general, results indicate that a large variety of VRP variants has been studied in the past years. We see a trend toward VRP variants that include real-life constraints and assumptions, which makes the models more realistic and the solution approaches more applicable in practice. Given their importance in modeling real-life problems, we pay specific attention to the Open VRP, Dynamic VRP and Time-Dependent VRP in Section 5.3. Additionally, real-life settings such as cash transportation (Yan, Wang, & Wu, 2012), small package shipping (Stenger, Vigo, Enz, & Schwind, 2013), garbage collection (Kuo, Zulvia, & Suryadi, 2012) or social legislation for drivers' working hours (Goel, 2009; Kok, Meyer, Kopfer, & Schutten, 2010; Rancourt, Cordeau, & Laporte, 2013), have motivated researchers to develop specific mathematical formulations and solution methods. In fact, most authors still propose highly problem-tailored methods that are not applicable to other VRP variants, and in which parameters are manipulated to provide good performance for the given instance (or for benchmark instances). Consequently, many of the proposed solution methods cannot be easily applied to other problem settings or in real-life applications. In our classification, only a few articles (e.g., Cordeau & Maischberger, 2012; Subramanian, Uchoa, & Ochi, 2013; Vidal, Crainic, Gendreau, & Prins, 2013a, 2014a) propose a "general" algorithm that can solve multiple variants of the VRP. The parallel iterated tabu search metaheuristic in Cordeau and Maischberger (2012) is applicable to the classical VRP, PVRP, MDVRP, the site-dependent VRP and their variants with time windows. Subramanian et al. (2013) present a hybrid heuristic combining a set partitioning approach with an iterated local search heuristic which is applied to six different variants of the VRP. The genetic search algorithm in Vidal et al. (2013a) can solve large scale VRPTW and extensions such as the periodic VRPTW, the multiple depot VRPTW, VRPTW with vehicle-site dependencies and their combinations, while the unified hybrid genetic search algorithm in Vidal et al. (2014a) efficiently solves even up to 29 variants of the VRP. Next to further research on including (multiple) real-life assumptions in vehicle routing problems, the further development of such general solution approaches seems highly worthwhile.

5.2. Combinations of characteristics

In this section, we present some insights on which characteristics often appear together, and which interesting combinations of characteristics have not yet been studied.

If stochastic information is considered, this is typically restricted to a single type of information, i.e., either stochastic demand quantities or stochastic travel times, not both. Such stochastic problems seem to be solved more often using exact methods or classical heuristics. Since it is hard to obtain stochastic information in real-life, almost solely artificial data is applied to test these methods. Additionally, stochastic problems more frequently consider only a single vehicle, probably due to problem complexity. In case of stochastic travel times, time windows appear more often (78%, compared to 38% on average). Typically these time windows are considered to be soft. In case of stochastic demand quantities, time windows appear less often (15%). For the latter problems, information is generally revealed locally (when arriving at the customer), and vehicles are assumed to travel back to the depot to be reloaded in case of route failures (recourse).

In problems in which information changes dynamically, other real-life aspects are often ignored, e.g., load splitting, multiple depots and heterogeneous vehicles never appear in dynamic problems, while backhauls are only considered in a single paper. Similar to problems with stochastic travel times, time windows are much more frequent (64% compared to 38% on average), and are more often assumed to be soft. Additionally, subset covering constraints are more common than on average (21% compared to 9%), since in many applications decisions makers may decline new requests in case they cannot be fulfilled (in a profitable way). Finally, no exact methods have been proposed for dynamic problems in the reviewed papers.

Backhauls are considered less than average in multi-vehicle and multi-period settings, and rarely in combination with dynamic or stochastic information. In case each customer requires either a linehaul or a backhaul service but not both, frequently precedence and coupling constraints are applied to indicate that linehaul customers should be visited before backhaul customers (57% compared to 9% on average). Precedence and coupling constraints itself, are also considered more often in single vehicle and single period problems, probably due to their complexity. In multiple period problems, multiple depots arise more frequently than on average, but vehicle capacities are taken into account less often. Finally, information is typically assumed to be deterministic in these multiple period problems.

In general, we observe that real-life characteristics are mostly considered either individually or with a limited number of other characteristics. Hence, many combinations of realistic characteristics are still unexplored. In order to make vehicle routing models even more realistic and readily applicable in practice, future research could focus on even 'richer' problems. Multiple real-life characteristics could be considered simultaneously, and efficient solution methods to solve these problems could be developed.

5.3. Specific problems

In the following paragraphs, we further zoom in on three specific variants of the VRP which model real-life aspects and which started to receive more research attention in recent years: the Open VRP, the Dynamic VRP and the Time-Dependent VRP. We expect these variants to become even more popular in the coming years.

5.3.1. Open VRP (OVRP)

In the Open VRP (OVRP) vehicles are not required to return to the central depot after visiting the last customer. If they do return, they must visit the same customers in the reverse order. Additionally, the OVRP often has two optimization objectives: minimizing the number of vehicles used and (given this number of vehicles) minimizing the total distance (or sometimes time) traveled (e.g., Fleszar, Osman, & Hindi, 2009; MirHassani & Abolghasemi, 2011; Subramanian et al., 2013; Zachariadis & Kiranoudis, 2010b), although some exceptions exist (e.g., Cao, Lai, & Yang, 2014; Norouzi, Tavakkoli-Moghaddam, Ghazanfari, Alinaghian, & Salamatbakhsh, 2012). In practice, the OVRP occurs when the vehicle fleet is not owned by the company itself or when the available vehicle fleet is unable to satisfy the demand of its customers, such that (part of) the distribution activities is contracted to a third party logistics (3PL) provider (Repoussis, Tarantilis, Bräysy, & Ioannou, 2010). The OVRP solution then indicates the amount of vehicles that is needed. In addition, the OVRP might be used in case of pick-up and delivery, when after delivering goods to given customers, the vehicles pick up goods from the same customers, but in reverse order (Salari, Toth, & Tramontani, 2010). In real-life the OVRP occurs for instance with home delivery of packages and newspapers (Repoussis et al., 2010), school bus routing (López-Sánchez, Hernández-Díaz, Vigo, Caballero, & Molina, 2014; Salari et al., 2010), routing of coal mines material (Yu, Ding, & Zhu, 2011) or shipment of hazardous materials (Liu & Jiang, 2012).

Thirteen of the classified articles have OVRP as (main) subject. All articles include capacity constraints for the vehicles. Additionally, more than half of the articles include distance (or time) constraints. All articles, except for one (Li, Leung, & Tian, 2012), assume a homogeneous fleet of vehicles and all but two (Cao & Lai, 2010; Cao et al., 2014) assume deterministic demands. All proposed solution methods are metaheuristics, except for one (Salari et al., 2010), and all but one (Yu et al., 2011) are tested on benchmark instances, either gathered from literature or generated by the authors. López-Sánchez et al. (2014) test their metaheuristic both on benchmark instances and on real data.

5.3.2. Dynamic VRP (DVRP)

The evolution of real-time technologies, such as Intelligent Transformation Systems (ITS), Advanced Fleet Management Systems (AFMS) and Global Positioning Systems (GPS), has made dynamic VRPs a relatively hot topic in recent years (Psaraftis, 1995): 14 (4.28%) of the classified articles discuss a DVRP. In a DVRP (also referred to as online or real-time VRP), the inputs are revealed or updated continuously. Based on these new inputs, vehicle routes are then adapted dynamically. A comprehensive review of the DVRP was recently presented by Pillac et al. (2013).

Dynamism is mostly considered with respect to customer requests. New requests are assumed to arrive in problems studied by e.g., Barkaoui and Gendreau (2013), Hong (2012), Khouadjia, Sarasola, Alba, Jourdan, and Talbi (2012), Lorini, Potvin, and Zufferey (2011), Wen, Cordeau, Laporte, and Larsen (2010). Mostly no information about future requests is assumed, although stochastic information (Albareda-Sambola, Fernández, & Laporte, 2014) or forecasts (Ferrucci et al., 2013) may be available. Pillac, Guéret, and Medaglia (2012) consider dynamic routing decisions as a consequence of actual demand only being revealed when arriving at the customers (although stochastic information is known beforehand). Dynamic travel times are considered by e.g., Liao and Hu (2011).

Strikingly, no standard problem definitions or formulations are available for dynamic VRPs (Hong, 2012; Psaraftis, 1995). Additionally, to the authors' knowledge, no benchmark instances are available to test and compare the proposed solution methods objectively.

5.3.3. Time dependent VRP (TDVRP)

Most VRPs assume that the travel times between depots and customers are deterministic and constant (e.g., Kok et al., 2010) or equal to the distance between customers (e.g., Lei, Laporte, & Guo, 2011; Li et al., 2012). In real life, variable travel times (due to congestion) are prevalent. The TDVRP assumes that the travel times are deterministic but no longer constant, i.e., they are a function of current time. As such, the effects of congestion on the total route duration, the number of vehicles and transportation cost can be determined.

All ten TDVRP articles in our classification (see electronic Appendix) satisfy the non-passing property, also known as the First-In First-Out (FIFO) property (Ichoua, Gendreau, & Potvin, 2003), which states that a vehicle that leaves earlier from some customer will arrive earlier at its destination. The time-dependent travel times are generally modeled following the example of Ichoua et al. (2003), where the workday is partitioned into several periods and a constant travel speed is assigned to each time interval, resulting in speed being a step function of the departure time for all the arcs. The higher the number of time intervals, the more realistic the model will be, because the travel speeds will change more gradually (Kok, Hans, & Schutten, 2012). The travel time between two customers is then dependent on the departure time from the first customer and the time-dependent speed on the associated arc between the two customers.

Six TDVRP articles in our classification assume time windows. Most of these time windows are strict (4 articles) and restrict the time of service at the customers. All TDVRP are deterministic except for the variant proposed by Lorini et al. (2011), who also take unforeseen events into account. All articles address single period problems with a single depot. Dabia, Ropke, van Woensel, and De Kok (2013) are the only authors to solve the TDVRP with time windows using an exact method. Their branch-and-price method was tested on the Solomon instances with speeds derived from real life.

6. Conclusions

This paper classifies 277 VRP articles published between 2009 and mid-2015 according to an adapted taxonomy based on Eksioglu et al. (2009). The resulting classification table (in electronic Appendix) enables future researchers to find relevant literature by eliminating or selecting characteristics in the taxonomy, leaving only articles tailored to their interests. Additionally, the classification allowed to analyze which characteristics and combinations of characteristics are most popular.

Results indicate that the vehicle routing literature consists of a broad range of problem variants. Researchers pay more and more attention to VRP variants that include real-life characteristics and assumptions, thereby making their models more realistic and their solution approaches more applicable in practice. However, real-life characteristics are often considered either individually or with a limited number of other characteristics. Future research could therefore focus on even 'richer' problems by simultaneously considering multiple real-life characteristics, and developing efficient solution methods to solve these problems. On the other hand, many researchers still propose highly problem-tailored solution methods which are not directly applicable to other problem variants. In our classification, only a few articles propose more general algorithms which can solve multiple variants. The further development of such general solution approaches seems highly worthwhile.

Appendix A. Overview of classified literature per year

See Table A.1.

Table A.1
Overview of classified literature per year.

Year of publication	References	Number of articles per year
2015	Allahyari, Salari, and Vigo (2015), Avci and Topaloglu (2015), Bertazzi, Golden, and Wang (2015), Dayarian, Crainic, Gendreau, and Rei (2015a, 2015b), Garcia-Najera and Bullinaria (2011), Hu, Sheu, Zhao, and Lu (2015), Janssens, Van den Bergh, Sörensen, and Cattrysse (2015), Lahyani, Coelho, et al. (2015), Lahyani, Khemakhem, et al. (2015), Li, Pardalos, Sun, Pei, and Zhang (2015), Luo, Qin, Che, and Lim (2015), McNabb, Weir, Hill, and Hall (2015), Montoya-Torres et al. (2015), Mouthuy, Massen, Deville, and Van Hentenryck (2015), Nagy, Wassan, Speranza, and Archetti (2015), Polat, Kalayci, Kulak, and Günther (2015), Rahimi-Vahed, Crainic, Gendreau, and Rei (2015), Silva, Subramanian, and Ochi (2015), Tang, Yu, and Li (2015), Vidal, Battarra, Subramanian, and Erdogan (2015), Wang, Mu, Zhao, and Sutherland (2015), Zachariadis, Tarantilis, and Kiranoudis (2015)	23
2014	Abdallah and Jang (2014), Albareda-Sambola et al. (2014), Allahviranloo, Chow, and Recker (2014), Amorim and Almada-Lobo (2014), Archetti, Bianchessi, and Speranza (2014), Azi, Gendreau, and Potvin (2014), Battarra, Erdoğan, and Vigo (2014), Belhaiza, Hansen, and Laporte (2014), Bhusiri, Qureshi, and Taniguchi (2014), Cacchiani, Hemmelmayr, and Tricoire (2014), Cao et al. (2014), Cattaruzza, Absi, Feillet, and Vidal (2014), Cattaruzza, Absi, Feillet, and Vigo (2014), Chen, Li, and Liu (2014), Chiang and Hsu (2014), Ćirović, Pamučar, and Božanić (2014), Demir, Bektaş, and Laporte (2014), Felipe, Ortuño, Righini, and Tirado (2014), Gauvin, Desaulniers, and Gendreau (2014), Hà, Bostel, Langevin, and Rousseau (2014), Han, Lee, and Park (2014), Jiang, Ng, Poh, and Teo (2014), Jin, Crainic, and Løkketangen (2014), Juan, Faulin, Caceres-Cruz, Barrios, and Martinez (2014), Krichen, Faiz, Tlili, and Tej (2014), Küçükoğlu and Öztürk (2014), Letchford, Nasiri, and Oukil (2014), Lin et al. (2014), López-Sánchez et al. (2014), Luo and Chen (2014), Lysgaard and Wøhlk (2014), Michallet, Prins, Amodeo, Yalaoui, and Vitry (2014), Morais, Mateus, and Noronha (2014), Muter, Cordeau, and Laporte (2014), Palhazi Cuervo, Goos, Sörensen, and Arráiz (2014), Prins, Lacomme, and Prodhon (2014), Salhi, Imran, and Wassan (2014), Schneider, Stenger, and Goeke (2014), Taş, Dellaert, van Woensel, and de Kok (2014), Taş, Gendreau, Dellaert, van Woensel, and de Kok (2014), Taş, Jabali, and Van Woensel (2014), Tu, Fang, Li, Shaw, and Chen (2014), Vidal et al. (2014a), Vidal, Crainic, Gendreau, and Prins (2014b), Yu and Qi (2014), Zhang, Lee, Choy, Ho, and Ip (2014), Zhu, Rousseau, Rei, and Li (2014)	47

Table A.1 (*continued*)

Year of publication	References	Number of articles per year
2013	Agra et al. (2013), Almoustafa, Hanafi, and Mladenovic (2013), Avella, Boccia, and Vasilyev (2013), Baños, Ortega, Gil, Fernández, and de Toro (2013), Baños, Ortega, Gil, Márquez, and de Toro (2013), Barkaoui and Gendreau (2013), Belfiore and Yoshizaki (2013), Dabia et al. (2013), Derigs, Pullmann, and Vogel (2013a, 2013b), Drexl (2013), Ferrucci et al. (2013), Fleming, Griffis, and Bell (2013), Goksal, Karaoglan, and Altiparmak (2013), Gounaris, Wiesemann, and Floudas (2013);Hu, Sun, and Liu (2013), Ke and Feng (2013), Kergosien, Lenté, Billaut, and Perrin (2013), Kwon, Choi, and Lee (2013), Leung, Zhang, Zhang, Hua, and Lim (2013), Liu, Xie, Augusto, and Rodriguez (2013), Liu (2013), Marinakis, Iordanidou, and Marinaki (2013), Nguyen, Crainic, and Toulouse (2013), Osaba, Carballedo, Diaz, and Perallos (2013), Pandelis, Karamatsoukis, and Kyriakidis (2013), Penna, Subramanian, and Ochi (2013), Pillac et al. (2013), Pop, Matei, and Sitar (2013), Pradenas et al. (2013), Rancourt et al. (2013), Salhi, Wassan, and Hajarat (2013), Schneider, Sand, and Stenger (2013), Sörensen and Schittekat (2013), Stenger et al. (2013), Subramanian et al. (2013), Tang, Ma, Guan, and Yan (2013), Tarantilis, Anagnostopoulou, and Repoussis (2013), Taş, Dellaert, van Woensel, and de Kok (2013), Vidal et al. (2013a), Vidal, Crainic, Gendreau, and Prins (2013b), Villegas, Prins, Prodhon, Medaglia, and Velasco (2013), Wy, Kim, and Kim (2013), Wy and Kim (2013), Xiao and Lo (2013), Yao, Hu, Zhang, and Wang (2013), Zachariadis, Tarantilis, and Kiranoudis (2013), Zhang, Lam, and Chen (2013), Zhang, Che, Cheang, Lim, and Qin (2013)	49
2012	Anbuudayasankar, Ganesh, Lenny Koh, and Ducq (2012), Archetti and Speranza (2012), Baldacci, Mingozzi, and Roberti (2012), Chardy and Klopfenstein (2012), Chen, Feng, and Soon Ong (2012), Cordeau and Maischberger (2012), Demir, Bektaş, and Laporte (2012), Drexl (2012b), Erdoğan and Miller-Hooks (2012), Figliozzi (2012), Goodson, Ohlmann, and Thomas (2012), Hong (2012), Jabali, Van Woensel, and de Kok (2012), Jin, Crainic, and Løkketangen (2012), Khouadjia et al. (2012), Kok et al. (2012), Kuo and Wang (2012), Li et al. (2012), Liu and Jiang (2012), Lu and Yu (2012), Ma, Cheang, Lim, Zhang, and Zhu (2012), Marinakis (2012), Mattos Ribeiro and Laporte (2012), Moghaddam, Ruiz, and Sadjadi (2012), Moon, Lee, and Seong (2012), Nazif and Lee (2012), Norouzi et al. (2012), Pandelis, Kyriakidis, and Dimitrakos (2012), Pillac et al. (2012), Pureza et al. (2012), Qi, Lin, Li, and Miao (2012), Rasmussen, Justesen, Dohn, and Larsen (2012), Rodríguez and Ruiz (2012), Subramanian, Penna, Uchoa, and Ochi (2012), Tarantilis, Stavropoulou, and Repoussis (2012), Tasan and Gen (2012), Vidal, Crainic, Gendreau, Lahrichi, and Rei (2012), Yan et al. (2012), Zachariadis and Kiranoudis (2012), Zhang, Chaovalitwongse, and Zhang (2012), Zhang, Qin, Zhu, and Lim (2012)	41
2011	Alabas-Uslu and Dengiz (2011), Aras, Aksen, and Tuğrul Tekin (2011), Archetti, Bouchard, and Desaulniers (2011), Baldacci, Bartolini, Mingozzi, and Valletta (2011), Baldacci, Mingozzi, and Roberti (2011), Balseiro, Loiseau, and Ramonet (2011), Bektas, Erdogan, and Ropke (2011), Bektaş and Laporte (2011), Bettinelli, Ceselli, and Righini (2011), Brandão (2011), Felipe, Ortuño, and Tirado (2011), Garcia-Najera and Bullinaria (2011), Gulczynski, Golden, and Wasil (2011a), Gulczynski et al. (2011b), Juan et al. (2011), Lei et al. (2011), Liao and Hu (2011), Lin (2011), Lorini et al. (2011), Macedo, Alves, Valério de Carvalho, Clautiaux, and Hanafi (2011), Mendoza et al. (2011), Minis and Tatarakis (2011), MirHassani and Abolghasemi (2011), Pang (2011), Salani and Vacca (2011), Santos, Coutinho-Rodrigues, and Antunes (2011), Szeto, Wu, and Ho (2011), Valle, Martinez, da Cunha, and Mateus (2011), Villegas, Prins, Prodhon, Medaglia, and Velasco (2011), Xu, Yan, and Li (2011), Yu and Yang (2011), Yu et al. (2011), Yu and Yang (2011), Yu et al. (2011), Yücenur and Demirel (2011)	35
2010	Azi, Gendreau, and Potvin (2010), Baldacci, Toth, and Vigo (2010), Benjamin and Beasley (2010), Bolduc, Laporte, Renaud, and Boctor (2010), Cao and Lai (2010), Çatay (2010), Chen, Huang, and Dong (2010), Cortés, Matamala, and Contardo (2010), Desaulniers (2010), Erera, Morales, and Savelsbergh (2010), Figliozzi (2010), Ghoseiri and Ghannadpour (2010), Gulczynski, Golden, and Wasil (2010), Gutiérrez-Jarpa, Desaulniers, Laporte, and Marianov (2010), Kok et al. (2010), Kuo (2010), Li, Tian, and Aneja (2010), Li, Tian, and Leung (2010), Liu, Jiang, Fung, Chen, and Liu (2010), Lysgaard (2010), Maden, Eglese, and Black (2010), Marinakis, Marinaki, and Dounias (2010), Marinakis and Marinaki (2010), Mendoza et al. (2010), Müller (2010), Muyldermans and Pang (2010), Nagata, Bräysy, and Dullaert (2010), Ngueveu et al. (2010), Prescott-Gagnon, Desaulniers, Drexl, and Rousseau (2010), Rei, Gendreau, and Soriano (2010), Ren, Dessouky, and Ordóñez (2010), Repoussis et al. (2010), Repoussis and Tarantilis (2010), Salari et al. (2010), Subramanian, Drummond, Bentes, Ochi, and Farias (2010), Tang, Zhang, and Pan (2010), Wen et al. (2010), Yazgı Tütüncü (2010), Yurtkuran and Emel (2010), Zachariadis and Kiranoudis (2010a, 2010b), Zachariadis, Tarantilis, and Kiranoudis (2010)	42
2009	Ai and Kachitvichyanukul (2009a, 2009b), Baldacci and Mingozzi (2009), Battarra, Monaci, and Vigo (2009), Belfiore and Yoshizaki (2009), Brandão (2009), Bräysy, Porkka, Dullaert, Repoussis, and Tarantilis (2009), Ceselli, Righini, and Salani (2009), Cheng and Wang (2009), Eksioglu et al. (2009), Figliozzi (2009), Fleszar et al. (2009), Gajpal and Abad P. (2009), Gajpal and Abad P.L. (2009), Goel (2009), Groër, Golden, and Wasil (2009), Hemmelmayr, Doerner, and Hartl (2009), Hoff, Gribkovskaia, Laporte, and Løkketangen (2009), Imran, Salhi, and Wassan (2009), Janssens, Caris, and Ramaekers (2009), Jozefowiez, Semet, and Talbi (2009), Karlaftis, Kepaptsoglou, and Sambracos (2009), Kim, Yang, and Lee (2009), Kuo, Wang, and Chuang (2009), Laporte (2009), Lin, Lee, Ying, and Lee (2009), Lin, Yu, and Chou (2009), Liu, Huang, and Ma (2009), Mendoza, Medaglia, and Velasco (2009), Moretti Branchini, Amaral Armentano, and Løkketangen (2009), Novoa and Storer (2009), Prescott-Gagnon, Desaulniers, and Rousseau (2009), Prins (2009), Qureshi, Taniguchi, and Yamada (2009), Ropke and Cordeau (2009), Secomandi and Margot (2009), Wang and Lu (2009), Yazgı Tütüncü, Carreto, and Baker (2009), Yu, Yang, and Yao (2009), Zachariadis, Tarantilis, and Kiranoudis (2009)	40

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.cie.2015.12.007.

References

Abdallah, K. S., & Jang, J. (2014). An exact solution for vehicle routing problems with semi-hard resource constraints. *Computers & Industrial Engineering, 76*, 366–377. http://dx.doi.org/10.1016/j.cie.2014.08.011.

Agra, A., Christiansen, M., Figueiredo, R., Hvattum, L. M., Poss, M., & Requejo, C. (2013). The robust vehicle routing problem with time windows. *Computers & Operations Research, 40*(3), 856–866.

Ai, T. J., & Kachitvichyanukul, V. (2009a). A particle swarm optimization for the vehicle routing problem with simultaneous pickup and delivery. *Computers & Operations Research, 36*(5), 1693–1702. http://dx.doi.org/10.1016/j.cor.2008.04.003.

Ai, T. J., & Kachitvichyanukul, V. (2009b). Particle swarm optimization and two solution representations for solving the capacitated vehicle routing problem. *Computers & Industrial Engineering, 56*(1), 380–387.

Alabas-Uslu, C., & Dengiz, B. (2011). A self-adaptive local search algorithm for the classical vehicle routing problem. *Expert Systems with Applications, 38*(7), 8990–8998. http://dx.doi.org/10.1016/j.eswa.2011.01.116.

Albareda-Sambola, M., Fernández, E., & Laporte, G. (2014). The dynamic multiperiod vehicle routing problem with probabilistic information. *Computers & Operations Research, 48*, 31–39. http://dx.doi.org/10.1016/j.cor.2014.02.010.

Allahviranloo, M., Chow, J. Y. J., & Recker, W. W. (2014). Selective vehicle routing problems under uncertainty without recourse. *Transportation Research Part E: Logistics and Transportation Review, 62*, 68–88. http://dx.doi.org/10.1016/j.tre.2013.12.004.

Allahyari, S., Salari, M., & Vigo, D. (2015). A hybrid metaheuristic algorithm for the multi-depot covering tour vehicle routing problem. *European Journal of Operational Research, 242*(3), 756–768. http://dx.doi.org/10.1016/j.ejor.2014.10.048.

Almoustafa, S., Hanafi, S., & Mladenovic, N. (2013). New exact method for large asymmetric distance-constrained vehicle routing problem. *European Journal of Operational Research, 226*(3), 386–394.

Amorim, P., & Almada-Lobo, B. (2014). The impact of food perishability issues in the vehicle routing problem. *Computers & Industrial Engineering, 67*, 223–233. http://dx.doi.org/10.1016/j.cie.2013.11.006.

Anbuudayasankar, S. P., Ganesh, K., Lenny Koh, S. C., & Ducq, Y. (2012). Modified savings heuristics and genetic algorithm for bi-objective vehicle routing problem with forced backhauls. *Expert Systems with Applications, 39*(3), 2296–2305. http://dx.doi.org/10.1016/j.eswa.2011.08.009.

Applegate, D. L., Bixby, R. E., Chvatal, V., & Cook, W. J. (2011). *The traveling salesman problem: A computational study*. Princeton University Press.

Aras, N., Aksen, D., & Tuğrul Tekin, M. (2011). Selective multi-depot vehicle routing problem with pricing. *Transportation Research Part C: Emerging Technologies, 19*(5), 866–884. http://dx.doi.org/10.1016/j.trc.2010.08.003.

Archetti, C., Bianchessi, N., & Speranza, M. G. (2014). Branch-and-cut algorithms for the split delivery vehicle routing problem. *European Journal of Operational Research, 238*(3), 685–698. http://dx.doi.org/10.1016/j.ejor.2014.04.026.

Archetti, C., Bouchard, M., & Desaulniers, G. (2011). Enhanced Branch and price and cut for vehicle routing with split deliveries and time windows. *Transportation Science, 45*(3), 285–298. http://dx.doi.org/10.1287/trsc.1100.0363.

Archetti, C., & Speranza, M. G. (2012). Vehicle routing problems with split deliveries. *International Transactions in Operational Research, 19*(1–2), 3–22. http://dx.doi.org/10.1111/j.1475-3995.2011.00811.x.

Avci, M., & Topaloglu, S. (2015). An adaptive local search algorithm for vehicle routing problem with simultaneous and mixed pickups and deliveries. *Computers & Industrial Engineering, 83*, 15–29. http://dx.doi.org/10.1016/j.cie.2015.02.002.

Avella, P., Boccia, M., & Vasilyev, I. (2013). Lifted and local reachability cuts for the vehicle routing problem with time windows. *Computers & Operations Research, 40*(8), 2004–2010. http://dx.doi.org/10.1016/j.cor.2013.03.008.

Azi, N., Gendreau, M., & Potvin, J.-Y. (2010). An exact algorithm for a vehicle routing problem with time windows and multiple use of vehicles. *European Journal of Operational Research, 202*(3), 756–763. http://dx.doi.org/10.1016/j.ejor.2009.06.034.

Azi, N., Gendreau, M., & Potvin, J.-Y. (2014). An adaptive large neighborhood search for a vehicle routing problem with multiple routes. *Computers & Operations Research, 41*, 167–173. http://dx.doi.org/10.1016/j.cor.2013.08.016.

Baldacci, R., Bartolini, E., Mingozzi, A., & Valletta, A. (2011). An exact algorithm for the period routing problem. *Operations Research*. Retrieved from <http://pubsonline.informs.org/doi/10.1287/opre.1100.0875>.

Baldacci, R., & Mingozzi, A. (2009). A unified exact method for solving different classes of vehicle routing problems. *Mathematical Programming, 120*(2), 347–380. http://dx.doi.org/10.1007/s10107-008-0218-9.

Baldacci, R., Mingozzi, A., & Roberti, R. (2011). New route relaxation and pricing strategies for the vehicle routing problem. *Operations Research, 59*(5), 1269–1283. http://dx.doi.org/10.1287/opre.1110.0975.

Baldacci, R., Mingozzi, A., & Roberti, R. (2012). Recent exact algorithms for solving the vehicle routing problem under capacity and time window constraints. *European Journal of Operational Research, 218*(1), 1–6. http://dx.doi.org/10.1016/j.ejor.2011.07.037.

Baldacci, R., Mingozzi, A., Roberti, R., & Calvo, R. W. (2013). An exact algorithm for the two-echelon capacitated vehicle routing problem. *Operations Research, 61*(2), 298–314. Retrieved from <http://pubsonline.informs.org/doi/abs/10.1287/opre.1120.1153>.

Baldacci, R., Toth, P., & Vigo, D. (2010). Exact algorithms for routing problems under vehicle capacity constraints. *Annals of Operations Research, 175*(1), 213–245. http://dx.doi.org/10.1007/s10479-009-0650-0.

Balseiro, S. R., Loiseau, I., & Ramonet, J. (2011). An ant colony algorithm hybridized with insertion heuristics for the time dependent vehicle routing problem with time windows. *Computers & Operations Research, 38*(6), 954–966. http://dx.doi.org/10.1016/j.cor.2010.10.011.

Baños, R., Ortega, J., Gil, C., Fernández, A., & de Toro, F. (2013). A simulated annealing-based parallel multi-objective approach to vehicle routing problems with time windows. *Expert Systems with Applications, 40*(5), 1696–1707.

Baños, R., Ortega, J., Gil, C., Márquez, A. L., & de Toro, F. (2013). A hybrid meta-heuristic for multi-objective vehicle routing problems with time windows. *Computers & Industrial Engineering, 65*(2), 286–296. http://dx.doi.org/10.1016/j.cie.2013.01.007.

Barkaoui, M., & Gendreau, M. (2013). An adaptive evolutionary approach for real-time vehicle routing and dispatching. *Computers & Operations Research, 40*(7), 1766–1776. http://dx.doi.org/10.1016/j.cor.2013.01.022.

Battarra, M., Erdoğan, G., & Vigo, D. (2014). Exact algorithms for the clustered vehicle routing problem. *Operations Research, 62*(1), 58–71. http://dx.doi.org/10.1287/opre.2013.1227.

Battarra, M., Monaci, M., & Vigo, D. (2009). An adaptive guidance approach for the heuristic solution of a minimum multiple trip vehicle routing problem. *Computers & Operations Research, 36*(11), 3041–3050. http://dx.doi.org/10.1016/j.cor.2009.02.008.

Bektas, T., Erdogan, G., & Ropke, S. (2011). Formulations and branch-and-cut algorithms for the generalized vehicle routing problem. *Transportation Science, 45*(3), 299–316. http://dx.doi.org/10.1287/trsc.1100.0352.

Bektaş, T., & Laporte, G. (2011). The pollution-routing problem. *Transportation Research Part B: Methodological, 45*(8), 1232–1250. http://dx.doi.org/10.1016/j.trb.2011.02.004.

Belfiore, P., & Yoshizaki, H. T. Y. (2009). Scatter search for a real-life heterogeneous fleet vehicle routing problem with time windows and split deliveries in Brazil. *European Journal of Operational Research, 199*(3), 750–758. http://dx.doi.org/10.1016/j.ejor.2008.08.003.

Belfiore, P., & Yoshizaki, H. T. Y. (2013). Heuristic methods for the fleet size and mix vehicle routing problem with time windows and split deliveries. *Computers & Industrial Engineering, 64*(2), 589–601.

Belhaiza, S., Hansen, P., & Laporte, G. (2014). A hybrid variable neighborhood tabu search heuristic for the vehicle routing problem with multiple time windows. *Computers & Operations Research, 52*, 269–281. http://dx.doi.org/10.1016/j.cor.2013.08.010.

Benjamin, A. M., & Beasley, J. E. (2010). Metaheuristics for the waste collection vehicle routing problem with time windows, driver rest period and multiple disposal facilities. *Computers & Operations Research, 37*(12), 2270–2280.

Berbeglia, G., Cordeau, J.-F., Gribkovskaia, I., & Laporte, G. (2007). Static pickup and delivery problems: A classification scheme and survey. *TOP, 15*(1), 1–31. http://dx.doi.org/10.1007/s11750-007-0009-0.

Bertazzi, L., Golden, B., & Wang, X. (2015). Min-max vs. min-sum vehicle routing: A worst-case analysis. *European Journal of Operational Research, 240*(2), 372–381. http://dx.doi.org/10.1016/j.ejor.2014.07.025.

Bertazzi, L., Savelsbergh, M., & Speranza, M. G. (2008). Inventory routing. In B. Golden, S. Raghavan, & E. Wasil (Eds.). *The Vehicle routing problem: Latest advances and new challenges* (Vol. 43, pp. 49–72). New York: Springer Science +Business Media. http://dx.doi.org/10.1007/978-0-387-77778-8.

Bettinelli, A., Ceselli, A., & Righini, G. (2011). A branch-and-cut-and-price algorithm for the multi-depot heterogeneous vehicle routing problem with time windows. *Transportation Research Part C: Emerging Technologies, 19*(5), 723–740. http://dx.doi.org/10.1016/j.trc.2010.07.008.

Bhusiri, N., Qureshi, A. G., & Taniguchi, E. (2014). The trade-off between fixed vehicle costs and time-dependent arrival penalties in a routing problem. *Transportation Research Part E: Logistics and Transportation Review, 62*, 1–22. http://dx.doi.org/10.1016/j.tre.2013.12.003.

Bolduc, M.-C., Laporte, G., Renaud, J., & Boctor, F. F. (2010). A tabu search heuristic for the split delivery vehicle routing problem with production and demand calendars. *European Journal of Operational Research, 202*(1), 122–130. http://dx.doi.org/10.1016/j.ejor.2009.05.008.

Brandão, J. (2009). A deterministic tabu search algorithm for the fleet size and mix vehicle routing problem. *European Journal of Operational Research, 195*(3), 716–728. http://dx.doi.org/10.1016/j.ejor.2007.05.059.

Brandão, J. (2011). A tabu search algorithm for the heterogeneous fixed fleet vehicle routing problem. *Computers & Operations Research, 38*(1), 140–151. http://dx.doi.org/10.1016/j.cor.2010.04.008.

Brar, G. S., & Saini, G. (2011). Milk run logistics: Literature Review and directions. In *Proceedings of the world congress on engineering* (Vol. 1, pp. 797–801). London, England.

Bräysy, O., & Gendreau, M. (2005a). Vehicle routing problem with time windows, Part I: Route construction and local search algorithms. *Transportation Science, 39*(1), 104–118. http://dx.doi.org/10.1287/trsc.1030.0056.

Bräysy, O., & Gendreau, M. (2005b). vehicle routing problem with time windows, Part II: Metaheuristics. *Transportation Science, 39*(1), 119–139. http://dx.doi.org/10.1287/trsc.1030.0057.

Bräysy, O., Porkka, P. P., Dullaert, W., Repoussis, P. P., & Tarantilis, C. D. (2009). A well-scalable metaheuristic for the fleet size and mix vehicle routing problem with time windows. *Expert Systems with Applications, 36*(4), 8460–8475. http://dx.doi.org/10.1016/j.eswa.2008.10.040.

Cacchiani, V., Hemmelmayr, V. C., & Tricoire, F. (2014). A set-covering based heuristic algorithm for the periodic vehicle routing problem. *Discrete Applied Mathematics (Amsterdam, Netherlands: 1988), 163*(Pt 1), 53–64. http://dx.doi.org/10.1016/j.dam.2012.08.032.

Campbell, A. M., & Wilson, J. H. (2014). Forty years of periodic vehicle routing. *Networks, 63*(1), 2–15. http://dx.doi.org/10.1002/net.21527.

Cao, E., & Lai, M. (2010). The open vehicle routing problem with fuzzy demands. *Expert Systems with Applications, 37*(3), 2405–2411. http://dx.doi.org/10.1016/j.eswa.2009.07.021.

Cao, E., Lai, M., & Yang, H. (2014). Open vehicle routing problem with demand uncertainty and its robust strategies. *Expert Systems with Applications, 41*(7), 3569–3575. http://dx.doi.org/10.1016/j.eswa.2013.11.004.

Çatay, B. (2010). A new saving-based ant algorithm for the vehicle routing problem with simultaneous pickup and delivery. *Expert Systems with Applications, 37*(10), 6809–6817. http://dx.doi.org/10.1016/j.eswa.2010.03.045.

Cattaruzza, D., Absi, N., Feillet, D., & Vidal, T. (2014). A memetic algorithm for the multi trip vehicle routing problem. *European Journal of Operational Research, 236*(3), 833–848. http://dx.doi.org/10.1016/j.ejor.2013.06.012.

Cattaruzza, D., Absi, N., Feillet, D., & Vigo, D. (2014). An iterated local search for the multi-commodity multi-trip vehicle routing problem with time windows. *Computers & Operations Research, 51*, 257–267. http://dx.doi.org/10.1016/j.cor.2014.06.006.

Ceselli, A., Righini, G., & Salani, M. (2009). A column generation algorithm for a rich vehicle-routing problem. *Transportation Science, 43*(1), 56–69. http://dx.doi.org/10.1287/trsc.1080.0256.

Chardy, M., & Klopfenstein, O. (2012). Handling uncertainties in vehicle routing problems through data preprocessing. *Transportation Research Part E: Logistics and Transportation Review, 48*(3), 667–683. http://dx.doi.org/10.1016/j.tre.2011.12.001.

Chen, X., Feng, L., & Soon Ong, Y. (2012). A self-adaptive memeplexes robust search scheme for solving stochastic demands vehicle routing problem. *International Journal of Systems Science, 43*(7), 1347–1366. http://dx.doi.org/10.1080/00207721.2011.618646.

Chen, H.-K., Hsueh, C.-F., & Chang, M.-S. (2009). Production scheduling and vehicle routing with time windows for perishable food products. *Computers &*

Operations Research, 36(7), 2311–2319. http://dx.doi.org/10.1016/j.cor.2008.09.010.

Chen, P., Huang, H., & Dong, X.-Y. (2010). Iterated variable neighborhood descent algorithm for the capacitated vehicle routing problem. *Expert Systems with Applications, 37*(2), 1620–1627. http://dx.doi.org/10.1016/j.eswa.2009.06.047.

Chen, Q., Li, K., & Liu, Z. (2014). Model and algorithm for an unpaired pickup and delivery vehicle routing problem with split loads. *Transportation Research Part E: Logistics and Transportation Review, 69*, 218–235. http://dx.doi.org/10.1016/j.tre.2014.06.010.

Cheng, C.-B., & Wang, K.-P. (2009). Solving a vehicle routing problem with time windows by a decomposition technique and a genetic algorithm. *Expert Systems with Applications, 36*(4), 7758–7763. http://dx.doi.org/10.1016/j.eswa.2008.09.001.

Chiang, T.-C., & Hsu, W.-H. (2014). A knowledge-based evolutionary algorithm for the multiobjective vehicle routing problem with time windows. *Computers & Operations Research, 45*, 25–37. http://dx.doi.org/10.1016/j.cor.2013.11.014.

Ćirović, G., Pamučar, D., & Božanić, D. (2014). Green logistic vehicle routing problem: Routing light delivery vehicles in urban areas using a neuro-fuzzy model. *Expert Systems with Applications, 41*(9), 4245–4258. http://dx.doi.org/10.1016/j.eswa.2014.01.005.

Clarke, G., & Wright, J. W. (1964). Scheduling of vehicles from a central depot to a number of delivery points. *Operations Research, 12*(4), 568–582. http://dx.doi.org/10.1287/opre.12.4.568.

Coelho, L. C., Cordeau, J.-F., & Laporte, G. (2014). Thirty years of inventory routing. *Transportation Science, 48*(1), 1–19. http://dx.doi.org/10.1287/trsc.2013.0472.

Cordeau, J.-F., & Maischberger, M. (2012). A parallel iterated tabu search heuristic for vehicle routing problems. *Computers & Operations Research, 39*(9), 2033–2050. http://dx.doi.org/10.1016/j.cor.2011.09.021.

Cortés, C. E., Matamala, M., & Contardo, C. (2010). The pickup and delivery problem with transfers: Formulation and a branch-and-cut solution method. *European Journal of Operational Research, 200*(3), 711–724. http://dx.doi.org/10.1016/j.ejor.2009.01.022.

Dabia, S., Ropke, S., van Woensel, T., & De Kok, T. (2013). Branch and price for the time-dependent vehicle routing problem with time windows. *Transportation Science, 47*(3), 380–396. http://dx.doi.org/10.1287/trsc.1120.0445.

Dantzig, G. B., & Ramser, J. H. (1959). The truck dispatching problem. *Management Science, 6*(1), 80–92. http://dx.doi.org/10.1287/mnsc.6.1.80.

Dayarian, I., Crainic, T. G., Gendreau, M., & Rei, W. (2015a). A branch-and-price approach for a multi-period vehicle routing problem. *Computers & Operations Research, 55*, 167–184. http://dx.doi.org/10.1016/j.cor.2014.06.004.

Dayarian, I., Crainic, T. G., Gendreau, M., & Rei, W. (2015b). A column generation approach for a multi-attribute vehicle routing problem. *European Journal of Operational Research, 241*(3), 888–906. http://dx.doi.org/10.1016/j.ejor.2014.09.015.

Demir, E., Bektaş, T., & Laporte, G. (2012). An adaptive large neighborhood search heuristic for the pollution-routing problem. *European Journal of Operational Research, 223*(2), 346–359. http://dx.doi.org/10.1016/j.ejor.2012.06.044.

Demir, E., Bektaş, T., & Laporte, G. (2014). The bi-objective pollution-routing problem. *European Journal of Operational Research, 232*(3), 464–478. http://dx.doi.org/10.1016/j.ejor.2013.08.002.

Derigs, U., Pullmann, M., & Vogel, U. (2013a). A short note on applying a simple LS/LNS-based metaheuristic to the rollon–rolloff vehicle routing problem. *Computers & Operations Research, 40*(3), 867–872.

Derigs, U., Pullmann, M., & Vogel, U. (2013b). Truck and trailer routing—Problems, heuristics and computational experience. *Computers & Operations Research, 40*(2), 536–546. http://dx.doi.org/10.1016/j.cor.2012.08.007.

Desaulniers, G. (2010). Branch-and-Price-and-cut for the split-delivery vehicle routing problem with time windows. *Operations Research, 58*(1), 179–192. http://dx.doi.org/10.1287/opre.1090.0713.

Drexl, M. (2012a). Rich vehicle routing in theory and practice. *Logistics Research, 5*(1–2), 47–63.

Drexl, M. (2012b). Synchronization in vehicle routing – A survey of VRPs with multiple synchronization constraints. *Transportation Science, 46*(3), 297–316. http://dx.doi.org/10.1287/trsc.1110.0400.

Drexl, M. (2013). Applications of the vehicle routing problem with trailers and transshipments. *European Journal of Operational Research, 227*(2), 275–284. http://dx.doi.org/10.1016/j.ejor.2012.12.015.

Eksioglu, B., Vural, A. V., & Reisman, A. (2009). The vehicle routing problem: A taxonomic review. *Computers & Industrial Engineering, 57*(4), 1472–1483. http://dx.doi.org/10.1016/j.cie.2009.05.009.

Erdoğan, S., & Miller-Hooks, E. (2012). A green vehicle routing problem. *Transportation Research Part E: Logistics and Transportation Review, 48*(1), 100–114. http://dx.doi.org/10.1016/j.tre.2011.08.001.

Erera, A. L., Morales, J. C., & Savelsbergh, M. (2010). The vehicle routing problem with stochastic demand and duration constraints. *Transportation Science, 44*(4), 474–492. http://dx.doi.org/10.1287/trsc.1100.0324.

Felipe, Á., Ortuño, M. T., Righini, G., & Tirado, G. (2014). A heuristic approach for the green vehicle routing problem with multiple technologies and partial recharges. *Transportation Research Part E: Logistics and Transportation Review, 71*, 111–128. http://dx.doi.org/10.1016/j.tre.2014.09.003.

Felipe, Á., Ortuño, M. T., & Tirado, G. (2011). Using intermediate infeasible solutions to approach vehicle routing problems with precedence and loading constraints. *European Journal of Operational Research, 211*(1), 66–75. http://dx.doi.org/10.1016/j.ejor.2010.11.011.

Ferrucci, F., Bock, S., & Gendreau, M. (2013). A pro-active real-time control approach for dynamic vehicle routing problems dealing with the delivery of urgent goods. *European Journal of Operational Research, 225*(1), 130–141. http://dx.doi.org/10.1016/j.ejor.2012.09.016.

Figliozzi, M. A. (2009). Planning approximations to the average length of vehicle routing problems with time window constraints. *Transportation Research Part B: Methodological, 43*(4), 438–447. http://dx.doi.org/10.1016/j.trb.2008.08.004.

Figliozzi, M. A. (2010). An iterative route construction and improvement algorithm for the vehicle routing problem with soft time windows. *Transportation Research Part C: Emerging Technologies, 18*(5), 668–679. http://dx.doi.org/10.1016/j.trc.2009.08.005.

Figliozzi, M. A. (2012). The time dependent vehicle routing problem with time windows: Benchmark problems, an efficient solution algorithm, and solution characteristics. *Transportation Research Part E: Logistics and Transportation Review, 48*(3), 616–636. http://dx.doi.org/10.1016/j.tre.2011.11.006.

Fleming, C. L., Griffis, S. E., & Bell, J. E. (2013). The effects of triangle inequality on the vehicle routing problem. *European Journal of Operational Research, 224*(1), 1–7. http://dx.doi.org/10.1016/j.ejor.2012.07.005.

Fleszar, K., Osman, I. H., & Hindi, K. S. (2009). A variable neighbourhood search algorithm for the open vehicle routing problem. *European Journal of Operational Research, 195*(3), 803–809. http://dx.doi.org/10.1016/j.ejor.2007.06.064.

Gajpal, Y., & Abad, P. (2009). An ant colony system (ACS) for vehicle routing problem with simultaneous delivery and pickup. *Computers & Operations Research, 36*(12), 3215–3223. http://dx.doi.org/10.1016/j.cor.2009.02.017.

Gajpal, Y., & Abad, P. L. (2009). Multi-ant colony system (MACS) for a vehicle routing problem with backhauls. *European Journal of Operational Research, 196*(1), 102–117. http://dx.doi.org/10.1016/j.ejor.2008.02.025.

Garcia-Najera, A., & Bullinaria, J. A. (2011). An improved multi-objective evolutionary algorithm for the vehicle routing problem with time windows. *Computers & Operations Research, 38*(1), 287–300. http://dx.doi.org/10.1016/j.cor.2010.05.004.

Gauvin, C., Desaulniers, G., & Gendreau, M. (2014). A branch-cut-and-price algorithm for the vehicle routing problem with stochastic demands. *Computers & Operations Research, 50*, 141–153. http://dx.doi.org/10.1016/j.cor.2014.03.028.

Gendreau, M., & Tarantilis, C. D. (2010). *Solving large-scale vehicle routing problems with time windows: The state-of-the-art*. Montreal.

Gendreau, M., Potvin, J.-Y., Bräysy, O., Hasle, G., & Lokketangen, A. (2008). Metaheuristics for the vehicle routing problem and its extensions: A categorized bibliography. In B. Golden, S. Raghavan, & E. Wasil (Eds.). *The vehicle routing problem: Latest advances and new challenges. Operations research/computer science interfaces series* (Vol. 43, pp. 143–169). Springer.

Ghoseiri, K., & Ghannadpour, S. F. (2010). Multi-objective vehicle routing problem with time windows using goal programming and genetic algorithm. *Applied Soft Computing, 10*(4), 1096–1107. http://dx.doi.org/10.1016/j.asoc.2010.04.001.

Glover, F. (1986). Future paths for integer programming and links to artificial intelligence. *Computers & Operations Research, 13*(5), 533–549. http://dx.doi.org/10.1016/0305-0548(86)90048-1.

Goel, A. (2009). Vehicle scheduling and routing with drivers' working hours. *Transportation Science, 43*(1), 17–26. http://dx.doi.org/10.1287/trsc.1070.0226.

Goksal, F. P., Karaoglan, I., & Altiparmak, F. (2013). A hybrid discrete particle swarm optimization for vehicle routing problem with simultaneous pickup and delivery. *Computers & Industrial Engineering, 65*(1), 39–53. http://dx.doi.org/10.1016/j.cie.2012.01.005.

Golden, B., Raghavan, S., & Wasil, E. (2008). *The vehicle routing problem: Latest advances and new challenges. Operations research/computer science interfaces series* (Vol. 43). Springer.

Goodson, J. C., Ohlmann, J. W., & Thomas, B. W. (2012). Cyclic-order neighborhoods with application to the vehicle routing problem with stochastic demand. *European Journal of Operational Research, 217*(2), 312–323. http://dx.doi.org/10.1016/j.ejor.2011.09.023.

Gounaris, C. E., Wiesemann, W., & Floudas, C. A. (2013). The robust capacitated vehicle routing problem under demand uncertainty. *Operations Research, 61*(3), 677–693. http://dx.doi.org/10.1287/opre.1120.1136.

Groër, C., Golden, B., & Wasil, E. (2009). The consistent vehicle routing problem. *Manufacturing & Service Operations Management, 11*(4), 630–643. http://dx.doi.org/10.1287/msom.1080.0243.

Gulczynski, D., Golden, B., & Wasil, E. (2010). The split delivery vehicle routing problem with minimum delivery amounts. *Transportation Research Part E: Logistics and Transportation Review, 46*(5), 612–626. http://dx.doi.org/10.1016/j.tre.2009.12.007.

Gulczynski, D., Golden, B., & Wasil, E. (2011a). The multi-depot split delivery vehicle routing problem: An integer programming-based heuristic, new test problems, and computational results. *Computers & Industrial Engineering, 61*(3), 794–804. http://dx.doi.org/10.1016/j.cie.2011.05.012.

Gulczynski, D., Golden, B., & Wasil, E. (2011b). The period vehicle routing problem: New heuristics and real-world variants. *Transportation Research Part E: Logistics and Transportation Review, 47*(5), 648–668. http://dx.doi.org/10.1016/j.tre.2011.02.002.

Gutiérrez-Jarpa, G., Desaulniers, G., Laporte, G., & Marianov, V. (2010). A branch-and-price algorithm for the vehicle routing problem with deliveries, selective pickups and time windows. *European Journal of Operational Research, 206*(2), 341–349. http://dx.doi.org/10.1016/j.ejor.2010.02.037.

Gutin, G., & Punnen, A. P. (2007). The traveling salesman problem and its variations. *Springer*. http://dx.doi.org/10.1007/b101971.

Hà, M. H., Bostel, N., Langevin, A., & Rousseau, L.-M. (2014). An exact algorithm and a metaheuristic for the generalized vehicle routing problem with flexible fleet size. *Computers & Operations Research, 43*, 9–19. http://dx.doi.org/10.1016/j.cor.2013.08.017.

Han, J., Lee, C., & Park, S. (2014). A robust scenario approach for the vehicle routing problem with uncertain travel times. *Transportation Science, 48*(3), 373–390. http://dx.doi.org/10.1287/trsc.2013.0476.

Hemmelmayr, V. C., Cordeau, J.-F., & Crainic, T. G. (2012). An adaptive large neighborhood search heuristic for two-echelon vehicle routing problems arising in city logistics. *Computers & Operations Research, 39*(12), 3215–3228.

Hemmelmayr, V. C., Doerner, K. F., & Hartl, R. F. (2009). A variable neighborhood search heuristic for periodic routing problems. *European Journal of Operational Research, 195*(3), 791–802. http://dx.doi.org/10.1016/j.ejor.2007.08.048.

Hoff, A., Gribkovskaia, I., Laporte, G., & Løkketangen, A. (2009). Lasso solution strategies for the vehicle routing problem with pickups and deliveries. *European Journal of Operational Research, 192*(3), 755–766. http://dx.doi.org/10.1016/j.ejor.2007.10.021.

Hong, L. (2012). An improved LNS algorithm for real-time vehicle routing problem with time windows. *Computers & Operations Research, 39*(2), 151–163. http://dx.doi.org/10.1016/j.cor.2011.03.006.

Hu, Z.-H., Sheu, J.-B., Zhao, L., & Lu, C.-C. (2015). A dynamic closed-loop vehicle routing problem with uncertainty and incompatible goods. *Transportation Research Part C: Emerging Technologies, 55*, 273–297. http://dx.doi.org/10.1016/j.trc.2015.01.010.

Hu, X., Sun, L., & Liu, L. (2013). A PAM approach to handling disruptions in real-time vehicle routing problems. *Decision Support Systems, 54*(3), 1380–1393.

Ichoua, S., Gendreau, M., & Potvin, J.-Y. (2003). Vehicle dispatching with time-dependent travel times. *European Journal of Operational Research, 144*(2), 379–396. http://dx.doi.org/10.1016/S0377-2217(02)00147-9.

Imran, A., Salhi, S., & Wassan, N. A. (2009). A variable neighborhood-based heuristic for the heterogeneous fleet vehicle routing problem. *European Journal of Operational Research, 197*(2), 509–518. http://dx.doi.org/10.1016/j.ejor.2008.07.022.

Jabali, O., Van Woensel, T., & de Kok, A. G. (2012). Analysis of travel times and CO_2 emissions in time-dependent vehicle routing. *Production and Operations Management, 21*(6), 1060–1074. http://dx.doi.org/10.1111/j.1937-5956.2012.01338.x.

Janssens, G. K., Caris, A., & Ramaekers, K. (2009). Time Petri nets as an evaluation tool for handling travel time uncertainty in vehicle routing solutions. *Expert Systems with Applications, 36*(3), 5987–5991. http://dx.doi.org/10.1016/j.eswa.2008.07.001.

Janssens, J., Van den Bergh, J., Sörensen, K., & Cattrysse, D. (2015). Multi-objective microzone-based vehicle routing for courier companies: From tactical to operational planning. *European Journal of Operational Research, 242*(1), 222–231. http://dx.doi.org/10.1016/j.ejor.2014.09.026.

Jiang, J., Ng, K. M., Poh, K. L., & Teo, K. M. (2014). Vehicle routing problem with a heterogeneous fleet and time windows. *Expert Systems with Applications, 41*(8), 3748–3760. http://dx.doi.org/10.1016/j.eswa.2013.11.029.

Jin, J., Crainic, T. G., & Løkketangen, A. (2012). A parallel multi-neighborhood cooperative tabu search for capacitated vehicle routing problems. *European Journal of Operational Research, 222*(3), 441–451. http://dx.doi.org/10.1016/j.ejor.2012.05.025.

Jin, J., Crainic, T. G., & Løkketangen, A. (2014). A cooperative parallel metaheuristic for the capacitated vehicle routing problem. *Computers & Operations Research, 44*, 33–41. http://dx.doi.org/10.1016/j.cor.2013.10.004.

Jozefowiez, N., Semet, F., & Talbi, E.-G. (2009). An evolutionary algorithm for the vehicle routing problem with route balancing. *European Journal of Operational Research, 195*(3), 761–769. http://dx.doi.org/10.1016/j.ejor.2007.06.065.

Juan, A. A., Faulin, J., Caceres-Cruz, J., Barrios, B. B., & Martinez, E. (2014). A successive approximations method for the heterogeneous vehicle routing problem: Analysing different fleet configurations. *European Journal of Industrial Engineering, 8*(6), 762–788. http://dx.doi.org/10.1504/EJIE.2014.066934.

Juan, A., Faulin, J., Grasman, S., Riera, D., Marull, J., & Mendez, C. (2011). Using safety stocks and simulation to solve the vehicle routing problem with stochastic demands. *Transportation Research Part C: Emerging Technologies, 19*(5), 751–765. http://dx.doi.org/10.1016/j.trc.2010.09.007.

Karlaftis, M. G., Kepaptsoglou, K., & Sambracos, E. (2009). Containership routing with time deadlines and simultaneous deliveries and pick-ups. *Transportation Research Part E: Logistics and Transportation Review, 45*(1), 210–221. http://dx.doi.org/10.1016/j.tre.2008.05.001.

Ke, L., & Feng, Z. (2013). A two-phase metaheuristic for the cumulative capacitated vehicle routing problem. *Computers & Operations Research, 40*(2), 633–638.

Kergosien, Y., Lenté, C., Billaut, J.-C., & Perrin, S. (2013). Metaheuristic algorithms for solving two interconnected vehicle routing problems in a hospital complex. *Computers & Operations Research, 40*(10), 2508–2518. http://dx.doi.org/10.1016/j.cor.2013.01.009.

Khouadjia, M. R., Sarasola, B., Alba, E., Jourdan, L., & Talbi, E.-G. (2012). A comparative study between dynamic adapted PSO and VNS for the vehicle routing problem with dynamic requests. *Applied Soft Computing, 12*(4), 1426–1439. http://dx.doi.org/10.1016/j.asoc.2011.10.023.

Kim, H., Yang, J., & Lee, K.-D. (2009). Vehicle routing in reverse logistics for recycling end-of-life consumer electronic goods in South Korea. *Transportation Research Part D: Transport and Environment, 14*(5), 291–299. http://dx.doi.org/10.1016/j.trd.2009.03.001.

Kirkpatrick, S., Gelatt, C. D., Jr., & Vecchi, M. P. (1983). Optimization by simulated annealing. *Science, 220*(4598), 671–680. http://dx.doi.org/10.1126/science.220.4598.671.

Kok, A. L., Hans, E. W., & Schutten, J. M. J. (2012). Vehicle routing under time-dependent travel times: The impact of congestion avoidance. *Computers & Operations Research, 39*(5), 910–918. http://dx.doi.org/10.1016/j.cor.2011.05.027.

Kok, A. L., Meyer, C. M., Kopfer, H., & Schutten, J. M. J. (2010). A Dynamic programming heuristic for the vehicle routing problem with time windows and european community social legislation. *Transportation Science, 44*(4), 442–454. http://dx.doi.org/10.1287/trsc.1100.0331.

Krichen, S., Faiz, S., Tlili, T., & Tej, K. (2014). Tabu-based GIS for solving the vehicle routing problem. *Expert Systems with Applications, 41*(14), 6483–6493. http://dx.doi.org/10.1016/j.eswa.2014.03.028.

Küçükoğlu, İ., & Öztürk, N. (2014). A differential evolution approach for the vehicle routing problem with backhauls and time windows. *Journal of Advanced Transportation, 48*(8), 942–956. http://dx.doi.org/10.1002/atr.1237.

Kuo, Y. (2010). Using simulated annealing to minimize fuel consumption for the time-dependent vehicle routing problem. *Computers & Industrial Engineering, 59*(1), 157–165. http://dx.doi.org/10.1016/j.cie.2010.03.012.

Kuo, Y., & Wang, C.-C. (2012). A variable neighborhood search for the multi-depot vehicle routing problem with loading cost. *Expert Systems with Applications, 39*(8), 6949–6954. http://dx.doi.org/10.1016/j.eswa.2012.01.024.

Kuo, Y., Wang, C.-C., & Chuang, P.-Y. (2009). Optimizing goods assignment and the vehicle routing problem with time-dependent travel speeds. *Computers & Industrial Engineering, 57*(4), 1385–1392. http://dx.doi.org/10.1016/j.cie.2009.07.006.

Kuo, R. J., Zulvia, F. E., & Suryadi, K. (2012). Hybrid particle swarm optimization with genetic algorithm for solving capacitated vehicle routing problem with fuzzy demand – A case study on garbage collection system. *Applied Mathematics and Computation, 219*(5), 2574–2588.

Kwon, Y.-J., Choi, Y.-J., & Lee, D.-H. (2013). Heterogeneous fixed fleet vehicle routing considering carbon emission. *Transportation Research Part D: Transport and Environment, 23*, 81–89. http://dx.doi.org/10.1016/j.trd.2013.04.001.

Lahyani, R., Coelho, L. C., Khemakhem, M., Laporte, G., & Semet, F. (2015). A multi-compartment vehicle routing problem arising in the collection of olive oil in Tunisia. *Omega, 51*, 1–10. http://dx.doi.org/10.1016/j.omega.2014.08.007.

Lahyani, R., Khemakhem, M., & Semet, F. (2015). Rich vehicle routing problems: From a taxonomy to a definition. *European Journal of Operational Research, 241*(1), 1–14. http://dx.doi.org/10.1016/j.ejor.2014.07.048.

Laporte, G. (2009). Fifty years of vehicle routing. *Transportation Science, 43*(4), 408–416. http://dx.doi.org/10.1287/trsc.1090.0301.

Lawler, E. L., Lenstra, J. K., Rinnooy Kan, A. H. G., & Shmoys, D. B. (1985). *The traveling salesman problem: A guided tour of combinatorial optimization*. Wiley.

Lei, H., Laporte, G., & Guo, B. (2011). The capacitated vehicle routing problem with stochastic demands and time windows. *Computers & Operations Research, 38*(12), 1775–1783. http://dx.doi.org/10.1016/j.cor.2011.02.007.

Lenstra, J. K., & Rinnooy Kan, A. H. G. (1981). Complexity of vehicle routing and scheduling problems. *Networks, 11*(2), 221–227.

Letchford, A. N., Nasiri, S. D., & Oukil, A. (2014). Pricing routines for vehicle routing with time windows on road networks. *Computers & Operations Research, 51*, 331–337. http://dx.doi.org/10.1016/j.cor.2014.06.022.

Leung, S. C. H., Zhang, Z., Zhang, D., Hua, X., & Lim, M. K. (2013). A meta-heuristic algorithm for heterogeneous fleet vehicle routing problems with two-dimensional loading constraints. *European Journal of Operational Research, 225*(2), 199–210. http://dx.doi.org/10.1016/j.ejor.2012.09.023.

Li, X., Leung, S. C. H., & Tian, P. (2012). A multistart adaptive memory-based tabu search algorithm for the heterogeneous fixed fleet open vehicle routing problem. *Expert Systems with Applications, 39*(1), 365–374. http://dx.doi.org/10.1016/j.eswa.2011.07.025.

Li, J., Pardalos, P. M., Sun, H., Pei, J., & Zhang, Y. (2015). Iterated local search embedded adaptive neighborhood selection approach for the multi-depot vehicle routing problem with simultaneous deliveries and pickups. *Expert Systems with Applications, 42*(7), 3551–3561. http://dx.doi.org/10.1016/j.eswa.2014.12.004.

Li, X., Tian, P., & Aneja, Y. P. (2010). An adaptive memory programming metaheuristic for the heterogeneous fixed fleet vehicle routing problem. *Transportation Research Part E: Logistics and Transportation Review, 46*(6), 1111–1127. http://dx.doi.org/10.1016/j.tre.2010.02.004.

Li, X., Tian, P., & Leung, S. C. H. (2010). Vehicle routing problems with time windows and stochastic travel and service times: Models and algorithm. *International Journal of Production Economics, 125*(1), 137–145. http://dx.doi.org/10.1016/j.ijpe.2010.01.013.

Liao, T.-Y., & Hu, T.-Y. (2011). An object-oriented evaluation framework for dynamic vehicle routing problems under real-time information. *Expert Systems with Applications, 38*(10), 12548–12558. http://dx.doi.org/10.1016/j.eswa.2011.04.041.

Liao, C.-J., Lin, Y., & Shih, S. C. (2010). Vehicle routing with cross-docking in the supply chain. *Expert Systems with Applications, 37*(10), 6868–6873. http://dx.doi.org/10.1016/j.eswa.2010.03.035.

Lin, S. (1965). Computer solutions of the traveling salesman problem. *Bell System Technical Journal, 44*(10), 2245–2269. http://dx.doi.org/10.1002/j.1538-7305.1965.tb04146.x.

Lin, C. K. Y. (2011). A vehicle routing problem with pickup and delivery time windows, and coordination of transportable resources. *Computers & Operations Research, 38*(11), 1596–1609. http://dx.doi.org/10.1016/j.cor.2011.01.021.

Lin, C., Choy, K. L., Ho, G. T. S., Chung, S. H., & Lam, H. Y. (2014). Survey of green vehicle routing problem: Past and future trends. *Expert Systems with Applications, 41*(4), 1118–1138. http://dx.doi.org/10.1016/j.eswa.2013.07.107.

Lin, S.-W., Lee, Z.-J., Ying, K.-C., & Lee, C.-Y. (2009). Applying hybrid meta-heuristics for capacitated vehicle routing problem. *Expert Systems with Applications, 36*(2), 1505–1512. http://dx.doi.org/10.1016/j.eswa.2007.11.060.

Lin, S.-W., Yu, V. F., & Chou, S.-Y. (2009). Solving the truck and trailer routing problem based on a simulated annealing heuristic. *Computers & Operations Research, 36*(5), 1683–1692. http://dx.doi.org/10.1016/j.cor.2008.04.005.

Liu, S. (2013). A hybrid population heuristic for the heterogeneous vehicle routing problems. *Transportation Research Part E: Logistics and Transportation Review, 54*, 67–78. http://dx.doi.org/10.1016/j.tre.2013.03.010.

Liu, S., Huang, W., & Ma, H. (2009). An effective genetic algorithm for the fleet size and mix vehicle routing problems. *Transportation Research Part E: Logistics and Transportation Review, 45*(3), 434–445. http://dx.doi.org/10.1016/j.tre.2008.10.003.

Liu, R., & Jiang, Z. (2012). The close–open mixed vehicle routing problem. *European Journal of Operational Research, 220*(2), 349–360. http://dx.doi.org/10.1016/j.ejor.2012.01.061.

Liu, R., Jiang, Z., Fung, R. Y. K., Chen, F., & Liu, X. (2010). Two-phase heuristic algorithms for full truckloads multi-depot capacitated vehicle routing problem in carrier collaboration. *Computers & Operations Research, 37*(5), 950–959. http://dx.doi.org/10.1016/j.cor.2009.08.002.

Liu, R., Xie, X., Augusto, V., & Rodriguez, C. (2013). Heuristic algorithms for a vehicle routing problem with simultaneous delivery and pickup and time windows in home health care. *European Journal of Operational Research, 230*(3), 475–486. http://dx.doi.org/10.1016/j.ejor.2013.04.044.

López-Sánchez, A. D., Hernández-Díaz, A. G., Vigo, D., Caballero, R., & Molina, J. (2014). A multi-start algorithm for a balanced real-world open vehicle routing problem. *European Journal of Operational Research, 238*(1), 104–113. http://dx.doi.org/10.1016/j.ejor.2014.04.008.

Lorini, S., Potvin, J.-Y., & Zufferey, N. (2011). Online vehicle routing and scheduling with dynamic travel times. *Computers & Operations Research, 38*(7), 1086–1090. http://dx.doi.org/10.1016/j.cor.2010.10.019.

Lu, C., & Yu, V. F. (2012). Data envelopment analysis for evaluating the efficiency of genetic algorithms on solving the vehicle routing problem with soft time windows. *Computers & Industrial Engineering, 63*(2), 520–529.

Luo, J., & Chen, M.-R. (2014). Improved shuffled frog leaping algorithm and its multi-phase model for multi-depot vehicle routing problem. *Expert Systems with Applications, 41*(5), 2535–2545. http://dx.doi.org/10.1016/j.eswa.2013.10.001.

Luo, Z., Qin, H., Che, C., & Lim, A. (2015). On service consistency in multi-period vehicle routing. *European Journal of Operational Research, 243*(3), 731–744. http://dx.doi.org/10.1016/j.ejor.2014.12.019.

Lysgaard, J. (2010). The pyramidal capacitated vehicle routing problem. *European Journal of Operational Research, 205*(1), 59–64. http://dx.doi.org/10.1016/j.ejor.2009.11.029.

Lysgaard, J., & Wøhlk, S. (2014). A branch-and-cut-and-price algorithm for the cumulative capacitated vehicle routing problem. *European Journal of Operational Research, 236*(3), 800–810. http://dx.doi.org/10.1016/j.ejor.2013.08.032.

Ma, H., Cheang, B., Lim, A., Zhang, L., & Zhu, Y. (2012). An investigation into the vehicle routing problem with time windows and link capacity constraints. *Omega, 40*(3), 336–347. http://dx.doi.org/10.1016/j.omega.2011.08.003.

Macedo, R., Alves, C., Valério de Carvalho, J. M., Clautiaux, F., & Hanafi, S. (2011). Solving the vehicle routing problem with time windows and multiple routes exactly using a pseudo-polynomial model. *European Journal of Operational Research, 214*(3), 536–545. http://dx.doi.org/10.1016/j.ejor.2011.04.037.

Maden, W., Eglese, R., & Black, D. (2010). Vehicle routing and scheduling with time-varying data: A case study. *Journal of the Operational Research Society, 61*(3), 515–522. http://dx.doi.org/10.1057/jors.2009.116.

Marinakis, Y. (2012). Multiple phase neighborhood search-GRASP for the capacitated vehicle routing problem. *Expert Systems with Applications, 39*(8), 6807–6815. http://dx.doi.org/10.1016/j.eswa.2012.01.015.

Marinakis, Y., Iordanidou, G.-R., & Marinaki, M. (2013). Particle swarm optimization for the vehicle routing problem with stochastic demands. *Applied Soft Computing, 13*(4), 1693–1704. http://dx.doi.org/10.1016/j.asoc.2013.01.007.

Marinakis, Y., & Marinaki, M. (2010). A hybrid genetic – Particle swarm optimization algorithm for the vehicle routing problem. *Expert Systems with Applications, 37*(2), 1446–1455. http://dx.doi.org/10.1016/j.eswa.2009.06.085.

Marinakis, Y., Marinaki, M., & Dounias, G. (2010). A hybrid particle swarm optimization algorithm for the vehicle routing problem. *Engineering Applications of Artificial Intelligence, 23*(4), 463–472. http://dx.doi.org/10.1016/j.engappai.2010.02.002.

Mattos Ribeiro, G., & Laporte, G. (2012). An adaptive large neighborhood search heuristic for the cumulative capacitated vehicle routing problem. *Computers & Operations Research, 39*(3), 728–735. http://dx.doi.org/10.1016/j.cor.2011.05.005.

McNabb, M. E., Weir, J. D., Hill, R. R., & Hall, S. N. (2015). Testing local search move operators on the vehicle routing problem with split deliveries and time windows. *Computers & Operations Research, 56*, 93–109. http://dx.doi.org/10.1016/j.cor.2014.11.007.

Mendoza, J. E., Castanier, B., Guéret, C., Medaglia, A. L., & Velasco, N. (2010). A memetic algorithm for the multi-compartment vehicle routing problem with stochastic demands. *Computers & Operations Research, 37*(11), 1886–1898. http://dx.doi.org/10.1016/j.cor.2009.06.015.

Mendoza, J. E., Castanier, B., Guéret, C., Medaglia, A. L., & Velasco, N. (2011). Constructive heuristics for the multicompartment vehicle routing problem with stochastic demands. *Transportation Science, 45*(3), 346–363. http://dx.doi.org/10.1287/trsc.1100.0353.

Mendoza, J. E., Medaglia, A. L., & Velasco, N. (2009). An evolutionary-based decision support system for vehicle routing: The case of a public utility. *Decision Support Systems, 46*(3), 730–742. http://dx.doi.org/10.1016/j.dss.2008.11.019.

Michallet, J., Prins, C., Amodeo, L., Yalaoui, F., & Vitry, G. (2014). Multi-start iterated local search for the periodic vehicle routing problem with time windows and time spread constraints on services. *Computers & Operations Research, 41*, 196–207. http://dx.doi.org/10.1016/j.cor.2013.07.025.

Minis, I., & Tatarakis, A. (2011). Stochastic single vehicle routing problem with delivery and pick up and a predefined customer sequence. *European Journal of Operational Research, 213*(1), 37–51. http://dx.doi.org/10.1016/j.ejor.2011.03.011.

MirHassani, S. A., & Abolghasemi, N. (2011). A particle swarm optimization algorithm for open vehicle routing problem. *Expert Systems with Applications, 38*(9), 11547–11551. http://dx.doi.org/10.1016/j.eswa.2011.03.032.

Moghaddam, B. F., Ruiz, R., & Sadjadi, S. J. (2012). Vehicle routing problem with uncertain demands: An advanced particle swarm algorithm. *Computers & Industrial Engineering, 62*(1), 306–317. http://dx.doi.org/10.1016/j.cie.2011.10.001.

Montoya-Torres, J. R., Lopez France, J., Nieto Isaza, S., Felizzola Jimenez, H., & Herazo-Padilla, N. (2015). A literature review on the vehicle routing problem with multiple depots. *Computers & Industrial Engineering, 79*, 115–129. http://dx.doi.org/10.1016/j.cie.2014.10.029.

Moon, I., Lee, J., & Seong, J. (2012). Vehicle routing problem with time windows considering overtime and outsourcing vehicles. *Expert Systems with Applications, 39*(18), 13202–13213.

Morais, V. W. C., Mateus, G. R., & Noronha, T. F. (2014). Iterated local search heuristics for the vehicle routing problem with cross-docking. *Expert Systems with Applications, 41*(16), 7495–7506. http://dx.doi.org/10.1016/j.eswa.2014.06.010.

Moretti Branchini, R., Amaral Armentano, V., & Løkketangen, A. (2009). Adaptive granular local search heuristic for a dynamic vehicle routing problem. *Computers & Operations Research, 36*(11), 2955–2968. http://dx.doi.org/10.1016/j.cor.2009.01.014.

Mouthuy, S., Massen, F., Deville, Y., & Van Hentenryck, P. (2015). A multistage very large-scale neighborhood search for the vehicle routing problem with soft time windows. *Transportation Science, 49*(2), 223–238. http://dx.doi.org/10.1287/trsc.2014.0558.

Müller, J. (2010). Approximative solutions to the bicriterion vehicle routing problem with time windows. *European Journal of Operational Research, 202*(1), 223–231. http://dx.doi.org/10.1016/j.ejor.2009.04.029.

Muter, I., Cordeau, J.-F., & Laporte, G. (2014). A branch-and-price algorithm for the multidepot vehicle routing problem with interdepot routes. *Transportation Science.*. Retrieved from <http://pubsonline.informs.org/doi/10.1287/trsc.2013.0489>.

Muyldermans, L., & Pang, G. (2010). On the benefits of co-collection: Experiments with a multi-compartment vehicle routing algorithm. *European Journal of Operational Research, 206*(1), 93–103. http://dx.doi.org/10.1016/j.ejor.2010.02.020.

Nagata, Y., Bräysy, O., & Dullaert, W. (2010). A penalty-based edge assembly memetic algorithm for the vehicle routing problem with time windows. *Computers & Operations Research, 37*(4), 724–737. http://dx.doi.org/10.1016/j.cor.2009.06.022.

Nagy, G., Wassan, N. A., Speranza, M. G., & Archetti, C. (2015). The vehicle routing problem with divisible deliveries and pickups. *Transportation Science, 49*(2), 271–294. http://dx.doi.org/10.1287/trsc.2013.0501.

Nazif, H., & Lee, L. S. (2012). Optimised crossover genetic algorithm for capacitated vehicle routing problem. *Applied Mathematical Modelling, 36*(5), 2110–2117. http://dx.doi.org/10.1016/j.apm.2011.08.010.

Ngueveu, S. U., Prins, C., & Wolfler Calvo, R. (2010). An effective memetic algorithm for the cumulative capacitated vehicle routing problem. *Computers & Operations Research, 37*(11), 1877–1885. http://dx.doi.org/10.1016/j.cor.2009.06.014.

Nguyen, P. K., Crainic, T. G., & Toulouse, M. (2013). A tabu search for time-dependent multi-zone multi-trip vehicle routing problem with time windows. *European Journal of Operational Research, 231*(1), 43–56. http://dx.doi.org/10.1016/j.ejor.2013.05.026.

Norouzi, N., Tavakkoli-Moghaddam, R., Ghazanfari, M., Alinaghian, M., & Salamatbakhsh, A. (2012). A new multi-objective competitive open vehicle routing problem solved by particle swarm optimization. *Networks and Spatial Economics, 12*(4), 609–633. http://dx.doi.org/10.1007/s11067-011-9169-4.

Novoa, C., & Storer, R. (2009). An approximate dynamic programming approach for the vehicle routing problem with stochastic demands. *European Journal of Operational Research, 196*(2), 509–515. http://dx.doi.org/10.1016/j.ejor.2008.03.023.

Osaba, E., Carballedo, R., Diaz, F., & Perallos, A. (2013). Discussion related to "Wang, C.-H., & Lu, J.-Z. (2009). A hybrid genetic algorithm that optimizes capacitated vehicle routing problem. Expert Systems with Applications, 36(2), 2921–2936". *Expert Systems with Applications, 40*(14), 5425–5426. http://dx.doi.org/10.1016/j.eswa.2013.04.008.

Palhazi Cuervo, D., Goos, P., Sörensen, K., & Arráiz, E. (2014). An iterated local search algorithm for the vehicle routing problem with backhauls. *European Journal of Operational Research, 237*(2), 454–464. http://dx.doi.org/10.1016/j.ejor.2014.02.011.

Pandelis, D. G., Karamatsoukis, C. C., & Kyriakidis, E. G. (2013). Finite and infinite-horizon single vehicle routing problems with a predefined customer sequence and pickup and delivery. *European Journal of Operational Research, 231*(3), 577–586. http://dx.doi.org/10.1016/j.ejor.2013.05.050.

Pandelis, D. G., Kyriakidis, E. G., & Dimitrakos, T. D. (2012). Single vehicle routing problems with a predefined customer sequence, compartmentalized load and stochastic demands. *European Journal of Operational Research, 217*(2), 324–332. http://dx.doi.org/10.1016/j.ejor.2011.09.027.

Pang, K.-W. (2011). An adaptive parallel route construction heuristic for the vehicle routing problem with time windows constraints. *Expert Systems with Applications, 38*(9), 11939–11946. http://dx.doi.org/10.1016/j.eswa.2011.03.088.

Partyka, J., & Hall, R. (2014). Vehicle routing software survey: VR delivers the goods. *ORMS-Today, 41*(1). Retrieved from <https://www.informs.org/ORMS-Today/Public-Articles/February-Volume-41-Number-1/Vehicle-Routing-Software-Survey-VR-delivers-the-goods>.

Penna, P. H. V., Subramanian, A., & Ochi, L. S. (2013). An iterated local search heuristic for the heterogeneous fleet vehicle routing problem. *Journal of Heuristics, 19*(2), 201–232. http://dx.doi.org/10.1007/s10732-011-9186-y.

Pillac, V., Gendreau, M., Guéret, C., & Medaglia, A. L. (2013). A review of dynamic vehicle routing problems. *European Journal of Operational Research, 225*(1), 1–11. http://dx.doi.org/10.1016/j.ejor.2012.08.015.

Pillac, V., Guéret, C., & Medaglia, A. L. (2012). An event-driven optimization framework for dynamic vehicle routing. *Decision Support Systems, 54*(1), 414–423. http://dx.doi.org/10.1016/j.dss.2012.06.007.

Polat, O., Kalayci, C. B., Kulak, O., & Günther, H.-O. (2015). A perturbation based variable neighborhood search heuristic for solving the vehicle routing problem with simultaneous pickup and delivery with time limit. *European Journal of Operational Research, 242*(2), 369–382. http://dx.doi.org/10.1016/j.ejor.2014.10.010.

Pollaris, H., Braekers, K., Caris, A., Janssens, G. K., & Limbourg, S. (2015). Vehicle routing problems with loading constraints: State-of-the-art and future directions. *OR Spectrum, 37*(2), 297–330. http://dx.doi.org/10.1007/s00291-014-0386-3.

Pop, P. C., Matei, O., & Sitar, C. P. (2013). An improved hybrid algorithm for solving the generalized vehicle routing problem. *Neurocomputing, 109*, 76–83. http://dx.doi.org/10.1016/j.neucom.2012.03.032.

Pradenas, L., Oportus, B., & Parada, V. (2013). Mitigation of greenhouse gas emissions in vehicle routing problems with backhauling. *Expert Systems with Applications, 40*(8), 2985–2991.

Prescott-Gagnon, E., Desaulniers, G., Drexl, M., & Rousseau, L.-M. (2010). European driver rules in vehicle routing with time windows. *Transportation Science, 44*(4), 455–473. http://dx.doi.org/10.1287/trsc.1100.0328.

Prescott-Gagnon, E., Desaulniers, G., & Rousseau, L.-M. (2009). A branch-and-price-based large neighborhood search algorithm for the vehicle routing problem with time windows. *Networks, 54*(4), 190–204. http://dx.doi.org/10.1002/net.20332.

Prins, C. (2009). Two memetic algorithms for heterogeneous fleet vehicle routing problems. *Engineering Applications of Artificial Intelligence, 22*(6), 916–928. http://dx.doi.org/10.1016/j.engappai.2008.10.006.

Prins, C., Lacomme, P., & Prodhon, C. (2014). Order-first split-second methods for vehicle routing problems: A review. *Technologies, 40*, 179–200. http://dx.doi.org/10.1016/j.trc.2014.01.011.

Prodhon, C., & Prins, C. (2014). A survey of recent research on location-routing problems. *European Journal of Operational Research, 238*(1), 1–17. http://dx.doi.org/10.1016/j.ejor.2014.01.005.

Psaraftis, H. N. (1995). Dynamic vehicle routing: Status and prospects. *Annals of Operations Research, 61*(1), 143–164.

Pureza, V., Morabito, R., & Reimann, M. (2012). Vehicle routing with multiple deliverymen: Modeling and heuristic approaches for the VRPTW. *European Journal of Operational Research, 218*(3), 636–647. http://dx.doi.org/10.1016/j.ejor.2011.12.005.

Qi, M., Lin, W.-H., Li, N., & Miao, L. (2012). A spatiotemporal partitioning approach for large-scale vehicle routing problems with time windows. *Transportation Research Part E: Logistics and Transportation Review, 48*(1), 248–257. http://dx.doi.org/10.1016/j.tre.2011.07.001.

Qureshi, A. G., Taniguchi, E., & Yamada, T. (2009). An exact solution approach for vehicle routing and scheduling problems with soft time windows. *Transportation Research Part E: Logistics and Transportation Review, 45*(6), 960–977. http://dx.doi.org/10.1016/j.tre.2009.04.007.

Rahimi-Vahed, A., Crainic, T. G., Gendreau, M., & Rei, W. (2015). Fleet-sizing for multi-depot and periodic vehicle routing problems using a modular heuristic algorithm. *Computers & Operations Research, 53*, 9–23. http://dx.doi.org/10.1016/j.cor.2014.07.004.

Rancourt, M.-E., Cordeau, J.-F., & Laporte, G. (2013). Long-haul vehicle routing and scheduling with working hour rules. *Transportation Science, 47*(1), 81–107.

Rasmussen, M. S., Justesen, T., Dohn, A., & Larsen, J. (2012). The home care crew scheduling problem: Preference-based visit clustering and temporal dependencies. *European Journal of Operational Research, 219*(3), 598–610. http://dx.doi.org/10.1016/j.ejor.2011.10.048.

Rei, W., Gendreau, M., & Soriano, P. (2010). A hybrid Monte Carlo local branching algorithm for the single vehicle routing problem with stochastic demands. *Transportation Science, 44*(1), 136–146. http://dx.doi.org/10.1287/trsc.1090.0295.

Ren, Y., Dessouky, M., & Ordóñez, F. (2010). The multi-shift vehicle routing problem with overtime. *Computers & Operations Research, 37*(11), 1987–1998. http://dx.doi.org/10.1016/j.cor.2010.01.016.

Repoussis, P. P., & Tarantilis, C. D. (2010). Solving the fleet size and mix vehicle routing problem with time windows via adaptive memory programming. *Transportation Research Part C: Emerging Technologies, 18*(5), 695–712. http://dx.doi.org/10.1016/j.trc.2009.08.004.

Repoussis, P. P., Tarantilis, C. D., Bräysy, O., & Ioannou, G. (2010). A hybrid evolution strategy for the open vehicle routing problem. *Computers & Operations Research, 37*(3), 443–455. http://dx.doi.org/10.1016/j.cor.2008.11.003.

Rodríguez, A., & Ruiz, R. (2012). A study on the effect of the asymmetry on real capacitated vehicle routing problems. *Computers & Operations Research, 39*(9), 2142–2151. http://dx.doi.org/10.1016/j.cor.2011.10.023.

Ropke, S., & Cordeau, J.-F. (2009). Branch and cut and price for the pickup and delivery problem with time windows. *Transportation Science, 43*(3), 267–286. http://dx.doi.org/10.1287/trsc.1090.0272.

Salani, M., & Vacca, I. (2011). Branch and price for the vehicle routing problem with discrete split deliveries and time windows. *European Journal of Operational Research, 213*(3), 470–477. http://dx.doi.org/10.1016/j.ejor.2011.03.023.

Salari, M., Toth, P., & Tramontani, A. (2010). An ILP improvement procedure for the open vehicle routing problem. *Computers & Operations Research, 37*(12), 2106–2120. http://dx.doi.org/10.1016/j.cor.2010.02.010.

Salhi, S., Imran, A., & Wassan, N. A. (2014). The multi-depot vehicle routing problem with heterogeneous vehicle fleet: Formulation and a variable neighborhood search implementation. *Computers & Operations Research, 52*, 315–325. http://dx.doi.org/10.1016/j.cor.2013.05.011.

Salhi, S., Wassan, N., & Hajarat, M. (2013). The fleet size and mix vehicle routing problem with backhauls: Formulation and set partitioning-based heuristics. *Transportation Research Part E: Logistics and Transportation Review, 56*, 22–35. http://dx.doi.org/10.1016/j.tre.2013.05.005.

Santos, L., Coutinho-Rodrigues, J., & Antunes, C. H. (2011). A web spatial decision support system for vehicle routing using Google Maps. *Decision Support Systems, 51*(1), 1–9. http://dx.doi.org/10.1016/j.dss.2010.11.008.

Schneider, M., Sand, B., & Stenger, A. (2013). A note on the time travel approach for handling time windows in vehicle routing problems. *Computers & Operations Research, 40*(10), 2564–2568. http://dx.doi.org/10.1016/j.cor.2013.02.002.

Schneider, M., Stenger, A., & Goeke, D. (2014). The electric vehicle-routing problem with time windows and recharging stations. *Transportation Science, 48*(4), 500–520. http://dx.doi.org/10.1287/trsc.2013.0490.

Secomandi, N., & Margot, F. (2009). Reoptimization approaches for the vehicle-routing problem with stochastic demands. *Operations Research, 57*(1), 214–230. http://dx.doi.org/10.1287/opre.1080.0520.

Silva, M. M., Subramanian, A., & Ochi, L. S. (2015). An iterated local search heuristic for the split delivery vehicle routing problem. *Computers & Operations Research, 53*, 234–249. http://dx.doi.org/10.1016/j.cor.2014.08.005.

Sörensen, K., & Schittekat, P. (2013). Statistical analysis of distance-based path relinking for the capacitated vehicle routing problem. *Computers & Operations Research, 40*(12), 3197–3205. http://dx.doi.org/10.1016/j.cor.2013.02.005.

Stenger, A., Vigo, D., Enz, S., & Schwind, M. (2013). An adaptive variable neighborhood search algorithm for a vehicle routing problem arising in small package shipping. *Transportation Science, 47*(1), 64–80. http://dx.doi.org/10.1287/trsc.1110.0396.

Subramanian, A., Drummond, L. M. A., Bentes, C., Ochi, L. S., & Farias, R. (2010). A parallel heuristic for the vehicle routing problem with simultaneous pickup and delivery. *Computers & Operations Research, 37*(11), 1899–1911. http://dx.doi.org/10.1016/j.cor.2009.10.011.

Subramanian, A., Penna, P. H. V., Uchoa, E., & Ochi, L. S. (2012). A hybrid algorithm for the heterogeneous fleet vehicle routing problem. *European Journal of Operational Research, 221*(2), 285–295. http://dx.doi.org/10.1016/j.ejor.2012.03.016.

Subramanian, A., Uchoa, E., & Ochi, L. S. (2013). A hybrid algorithm for a class of vehicle routing problems. *Computers & Operations Research, 40*(10), 2519–2531. http://dx.doi.org/10.1016/j.cor.2013.01.013.

Szeto, W. Y., Wu, Y., & Ho, S. C. (2011). An artificial bee colony algorithm for the capacitated vehicle routing problem. *European Journal of Operational Research, 215*(1), 126–135. http://dx.doi.org/10.1016/j.ejor.2011.06.006.

Tang, J., Ma, Y., Guan, J., & Yan, C. (2013). A max–min ant system for the split delivery weighted vehicle routing problem. *Expert Systems with Applications, 40*(18), 7468–7477. http://dx.doi.org/10.1016/j.eswa.2013.06.068.

Tang, J., Yu, Y., & Li, J. (2015). An exact algorithm for the multi-trip vehicle routing and scheduling problem of pickup and delivery of customers to the airport. *Transportation Research Part E: Logistics and Transportation Review, 73*, 114–132. http://dx.doi.org/10.1016/j.tre.2014.11.001.

Tang, J., Zhang, J., & Pan, Z. (2010). A scatter search algorithm for solving vehicle routing problem with loading cost. *Expert Systems with Applications, 37*(6), 4073–4083. http://dx.doi.org/10.1016/j.eswa.2009.11.027.

Tarantilis, C. D., Anagnostopoulou, A. K., & Repoussis, P. P. (2013). Adaptive path relinking for vehicle routing and scheduling problems with product returns. *Transportation Science, 47*(3), 356–379. http://dx.doi.org/10.1287/trsc.1120.0439.

Tarantilis, C. D., Stavropoulou, F., & Repoussis, P. P. (2012). A template-based tabu search algorithm for the consistent vehicle routing problem. *Expert Systems with Applications, 39*(4), 4233–4239. http://dx.doi.org/10.1016/j.eswa.2011.09.111.

Taş, D., Dellaert, N., van Woensel, T., & de Kok, T. (2013). Vehicle routing problem with stochastic travel times including soft time windows and service costs. *Computers & Operations Research, 40*(1), 214–224.

Taş, D., Dellaert, N., van Woensel, T., & de Kok, T. (2014). The time-dependent vehicle routing problem with soft time windows and stochastic travel times. *Transportation Research Part C: Emerging Technologies, 48*, 66–83. http://dx.doi.org/10.1016/j.trc.2014.08.007.

Taş, D., Gendreau, M., Dellaert, N., van Woensel, T., & de Kok, A. G. (2014). Vehicle routing with soft time windows and stochastic travel times: A column generation and branch-and-price solution approach. *European Journal of Operational Research, 236*(3), 789–799. http://dx.doi.org/10.1016/j.ejor.2013.05.024.

Taş, D., Jabali, O., & Van Woensel, T. (2014). A vehicle routing problem with flexible time windows. *Computers & Operations Research, 52*, 39–54. http://dx.doi.org/10.1016/j.cor.2014.07.005.

Tasan, A. S., & Gen, M. (2012). A genetic algorithm based approach to vehicle routing problem with simultaneous pick-up and deliveries. *Computers & Industrial Engineering, 62*(3), 755–761. http://dx.doi.org/10.1016/j.cie.2011.11.025.

Toth, P., & Vigo, D. (2002). *The vehicle routing problem*. MOS-SIAM Series on Optimization, SIAM. http://dx.doi.org/10.1137/1.9780898718515.

Toth, P., & Vigo, D. (2014). *Vehicle routing: Problems, methods, and applications* (2nd ed.). Philadelphia: MOS-SIAM Series on Optimization, SIAM.

Tu, W., Fang, Z., Li, Q., Shaw, S.-L., & Chen, B. (2014). A bi-level Voronoi diagram-based metaheuristic for a large-scale multi-depot vehicle routing problem. *Transportation Research Part E: Logistics and Transportation Review, 61*, 84–97. http://dx.doi.org/10.1016/j.tre.2013.11.003.

Ullrich, C. A. (2013). Integrated machine scheduling and vehicle routing with time windows. *European Journal of Operational Research, 227*(1), 152–165. http://dx.doi.org/10.1016/j.ejor.2012.11.049.

Valle, C. A., Martinez, L. C., da Cunha, A. S., & Mateus, G. R. (2011). Heuristic and exact algorithms for a min–max selective vehicle routing problem. *Computers & Operations Research, 38*(7), 1054–1065. http://dx.doi.org/10.1016/j.cor.2010.10.010.

Vidal, T., Battarra, M., Subramanian, A., & Erdogan, G. (2015). Hybrid metaheuristics for the clustered vehicle routing problem. *Computers & Operations Research, 58*, 87–99. http://dx.doi.org/10.1016/j.cor.2014.10.019.

Vidal, T., Crainic, T. G., Gendreau, M., Lahrichi, N., & Rei, W. (2012). A hybrid genetic algorithm for multidepot and periodic vehicle routing problems. *Operations Research, 60*(3), 611–624. http://dx.doi.org/10.1287/opre.1120.1048.

Vidal, T., Crainic, T. G., Gendreau, M., & Prins, C. (2013a). A hybrid genetic algorithm with adaptive diversity management for a large class of vehicle routing problems with time-windows. *Computers & Operations Research, 40*(1), 475–489.

Vidal, T., Crainic, T. G., Gendreau, M., & Prins, C. (2013b). Heuristics for multi-attribute vehicle routing problems: A survey and synthesis. *European Journal of Operational Research, 231*(1), 1–21. http://dx.doi.org/10.1016/j.ejor.2013.02.053.

Vidal, T., Crainic, T. G., Gendreau, M., & Prins, C. (2014a). A unified solution framework for multi-attribute vehicle routing problems. *European Journal of Operational Research, 234*(3), 658–673. http://dx.doi.org/10.1016/j.ejor.2013.09.045.

Vidal, T., Crainic, T. G., Gendreau, M., & Prins, C. (2014b). Implicit depot assignments and rotations in vehicle routing heuristics. *European Journal of Operational Research, 237*(1), 15–28. http://dx.doi.org/10.1016/j.ejor.2013.12.044.

Villegas, J. G., Prins, C., Prodhon, C., Medaglia, A. L., & Velasco, N. (2011). A GRASP with evolutionary path relinking for the truck and trailer routing problem. *Computers & Operations Research, 38*(9), 1319–1334. http://dx.doi.org/10.1016/j.cor.2010.11.011.

Villegas, J. G., Prins, C., Prodhon, C., Medaglia, A. L., & Velasco, N. (2013). A matheuristic for the truck and trailer routing problem. *European Journal of Operational Research, 230*(2), 231–244. http://dx.doi.org/10.1016/j.ejor.2013.04.026.

Wang, C.-H., & Lu, J.-Z. (2009). A hybrid genetic algorithm that optimizes capacitated vehicle routing problems. *Expert Systems with Applications, 36*(2), 2921–2936. http://dx.doi.org/10.1016/j.eswa.2008.01.072.

Wang, C., Mu, D., Zhao, F., & Sutherland, J. W. (2015). A parallel simulated annealing method for the vehicle routing problem with simultaneous pickup–delivery and time windows. *Computers & Industrial Engineering, 83*, 111–122. http://dx.doi.org/10.1016/j.cie.2015.02.005.

Wen, M., Cordeau, J.-F., Laporte, G., & Larsen, J. (2010). The dynamic multi-period vehicle routing problem. *Computers & Operations Research, 37*(9), 1615–1623. http://dx.doi.org/10.1016/j.cor.2009.12.002.

Wy, J., & Kim, B.-I. (2013). A hybrid metaheuristic approach for the rollon–rolloff vehicle routing problem. *Computers & Operations Research, 40*(8), 1947–1952. http://dx.doi.org/10.1016/j.cor.2013.03.006.

Wy, J., Kim, B.-I., & Kim, S. (2013). The rollon–rolloff waste collection vehicle routing problem with time windows. *European Journal of Operational Research, 224*(3), 466–476. http://dx.doi.org/10.1016/j.ejor.2012.09.001.

Xiao, L., & Lo, H. K. (2013). Adaptive vehicle routing for risk-averse travelers. *Transportation Research Part C: Emerging Technologies, 36*, 460–479. http://dx.doi.org/10.1016/j.trc.2013.06.015.

Xu, J., Yan, F., & Li, S. (2011). Vehicle routing optimization with soft time windows in a fuzzy random environment. *Transportation Research Part E: Logistics and Transportation Review, 47*(6), 1075–1091. http://dx.doi.org/10.1016/j.tre.2011.04.002.

Yan, S., Wang, S., & Wu, M. (2012). A model with a solution algorithm for the cash transportation vehicle routing and scheduling problem. *Computers & Industrial Engineering, 63*(2), 464–473.

Yao, B., Hu, P., Zhang, M., & Wang, S. (2013). Artificial bee colony algorithm with scanning strategy for the periodic vehicle routing problem. *Simulation, 89*(6), 762–770. http://dx.doi.org/10.1177/0037549713481503.

Yazgı Tütüncü, G. (2010). An interactive GRAMPS algorithm for the heterogeneous fixed fleet vehicle routing problem with and without backhauls. *European Journal of Operational Research, 201*(2), 593–600. http://dx.doi.org/10.1016/j.ejor.2009.03.044.

Yazgı Tütüncü, G., Carreto, C. A., & Baker, B. M. (2009). A visual interactive approach to classical and mixed vehicle routing problems with backhauls☆. *Omega, 37*(1), 138–154. http://dx.doi.org/10.1016/j.omega.2006.11.001.

Yu, S., Ding, C., & Zhu, K. (2011). A hybrid GA–TS algorithm for open vehicle routing optimization of coal mines material. *Expert Systems with Applications, 38*(8), 10568–10573. http://dx.doi.org/10.1016/j.eswa.2011.02.108.

Yu, M., & Qi, X. (2014). A vehicle routing problem with multiple overlapped batches. *Transportation Research Part E: Logistics and Transportation Review, 61*, 40–55. http://dx.doi.org/10.1016/j.tre.2013.10.004.

Yu, B., & Yang, Z. Z. (2011). An ant colony optimization model: The period vehicle routing problem with time windows. *Transportation Research Part E: Logistics and Transportation Review, 47*(2), 166–181. http://dx.doi.org/10.1016/j.tre.2010.09.010.

Yu, B., Yang, Z.-Z., & Xie, J.-X. (2011). A parallel improved ant colony optimization for multi-depot vehicle routing problem. *Journal of the Operational Research Society, 62*(1), 183–188. http://dx.doi.org/10.1057/jors.2009.161.

Yu, B., Yang, Z. Z., & Yao, B. (2009). An improved ant colony optimization for vehicle routing problem. *European Journal of Operational Research, 196*(1), 171–176. http://dx.doi.org/10.1016/j.ejor.2008.02.028.

Yu, B., Yang, Z. Z., & Yao, B. (2011). A hybrid algorithm for vehicle routing problem with time windows. *Expert Systems with Applications, 38*(1), 435–441. http://dx.doi.org/10.1016/j.eswa.2010.06.082.

Yücenur, G. N., & Demirel, N. Ç. (2011). A new geometric shape-based genetic clustering algorithm for the multi-depot vehicle routing problem. *Expert Systems with Applications, 38*(9), 11859–11865. http://dx.doi.org/10.1016/j.eswa.2011.03.077.

Yurtkuran, A., & Emel, E. (2010). A new hybrid electromagnetism-like algorithm for capacitated vehicle routing problems. *Expert Systems with Applications, 37*(4), 3427–3433. http://dx.doi.org/10.1016/j.eswa.2009.10.005.

Zachariadis, E. E., & Kiranoudis, C. T. (2010a). A strategy for reducing the computational complexity of local search-based methods for the vehicle routing problem. *Computers & Operations Research, 37*(12), 2089–2105. http://dx.doi.org/10.1016/j.cor.2010.02.009.

Zachariadis, E. E., & Kiranoudis, C. T. (2010b). An open vehicle routing problem metaheuristic for examining wide solution neighborhoods. *Computers & Operations Research, 37*(4), 712–723. http://dx.doi.org/10.1016/j.cor.2009.06.021.

Zachariadis, E. E., & Kiranoudis, C. T. (2012). An effective local search approach for the vehicle routing problem with backhauls. *Expert Systems with Applications, 39*(3), 3174–3184. http://dx.doi.org/10.1016/j.eswa.2011.09.004.

Zachariadis, E. E., Tarantilis, C. D., & Kiranoudis, C. T. (2009). A hybrid metaheuristic algorithm for the vehicle routing problem with simultaneous delivery and pick-up service. *Expert Systems with Applications, 36*(2), 1070–1081. http://dx.doi.org/10.1016/j.eswa.2007.11.005.

Zachariadis, E. E., Tarantilis, C. D., & Kiranoudis, C. T. (2010). An adaptive memory methodology for the vehicle routing problem with simultaneous pick-ups and deliveries. *European Journal of Operational Research, 202*(2), 401–411. http://dx.doi.org/10.1016/j.ejor.2009.05.015.

Zachariadis, E. E., Tarantilis, C. D., & Kiranoudis, C. T. (2013). Designing vehicle routes for a mix of different request types, under time windows and loading constraints. *European Journal of Operational Research, 229*(2), 303–317. http://dx.doi.org/10.1016/j.ejor.2013.02.056.

Zachariadis, E. E., Tarantilis, C. D., & Kiranoudis, C. T. (2015). The load-dependent vehicle routing problem and its pick-up and delivery extension. *Transportation Research Part B: Methodological, 71*, 158–181. http://dx.doi.org/10.1016/j.trb.2014.11.004.

Zhang, T., Chaovalitwongse, W. A., & Zhang, Y. (2012). Scatter search for the stochastic travel-time vehicle routing problem with simultaneous pick-ups and deliveries. *Computers & Operations Research, 39*(10), 2277–2290. http://dx.doi.org/10.1016/j.cor.2011.11.021.

Zhang, Z., Che, O., Cheang, B., Lim, A., & Qin, H. (2013). A memetic algorithm for the multiperiod vehicle routing problem with profit. *European Journal of Operational Research, 229*(3), 573–584. http://dx.doi.org/10.1016/j.ejor.2012.11.059.

Zhang, J., Lam, W. H. K., & Chen, B. Y. (2013). A stochastic vehicle routing problem with travel time uncertainty: Trade-off between cost and customer service. *Networks and Spatial Economics, 13*(4), 471–496. http://dx.doi.org/10.1007/s11067-013-9190-x.

Zhang, S., Lee, C. K. M., Choy, K. L., Ho, W., & Ip, W. H. (2014). Design and development of a hybrid artificial bee colony algorithm for the environmental vehicle routing problem. *Transportation Research Part D: Transport and Environment, 31*, 85–99. http://dx.doi.org/10.1016/j.trd.2014.05.015.

Zhang, Z., Qin, H., Zhu, W., & Lim, A. (2012). The single vehicle routing problem with toll-by-weight scheme: A branch-and-bound approach. *European Journal of Operational Research, 220*(2), 295–304. http://dx.doi.org/10.1016/j.ejor.2012.01.035.

Zhu, L., Rousseau, L.-M., Rei, W., & Li, B. (2014). Paired cooperative reoptimization strategy for the vehicle routing problem with stochastic demands. *Computers & Operations Research, 50*, 1–13. http://dx.doi.org/10.1016/j.cor.2014.03.027.