Routing and scheduling in Home Health Care: A Literature Survey and Bibliometric Analysis

Maria Di Mascolo, Clea Martinez, Marie-Laure Espinouse

Routing and scheduling in Home Health Care: A Literature Survey and Bibliometric Analysis

Maria Di Mascolo*[a], Cléa Martinez[b], Marie-Laure Espinouse[a]

[a] *Univ. Grenoble Alpes, CNRS, Grenoble INP**, G-SCOP, 38000 Grenoble, France*
** *Institute of Engineering Univ. Grenoble Alpes*
[b] *Industrial Engineering Department-University of Toulouse-IMT Mines Albi, Route de Teillet 81000 Albi, France*

*Corresponding author
Email addresses: Maria.Di-Mascolo@grenoble-inp.fr (Maria Di Mascolo*), clea.martinez@mines-albi.fr (Cléa Martinez), Marie-Laure.Espinouse@grenoble-inp.fr (Marie-Laure Espinouse)

Routing and scheduling in Home Health Care: A Literature Survey and Bibliometric Analysis

Abstract

Home Health Care (HHC) agencies aim at providing care and/or services to patients, at their homes, ensuring a quality of service at least equivalent to that given in a hospital, while controlling costs and improving living conditions.

The purpose of this paper is to propose a literature survey on "Home Health Care problems" dealing with routing and scheduling, to provide an overview of the constraints and objectives addressed by Operations Research and Industrial Engineering tools for both theoretical and practical HHC problems.

Based on an exhaustive methodology, the current state-of-the-art is reviewed, analyzed, and summarized. We focus not only on the methods used in the different papers studied but also and mainly on constraints and objectives which are specific to the HHC context, particularly highlighting the uncertain and dynamic aspects present in a growing number of papers.

This literature survey enables us to identify several research directions, discussed at the end of this paper. It makes it possible for researchers to identify unaddressed problems, or to direct their research towards one or another method according to the constraints and objectives under consideration, while for practitioners, it enables them to see whether their problem has given rise to the development of planning methods.

The main contributions of this paper are a synthesis update of the literature dealing with routing and scheduling in the HHC context, a set of comprehensive tables classifying the papers, some discussions on current trends with a focus on the uncertain and dynamic aspects, and future research directions.

Keywords: Home health care, Home service, Routing and scheduling, Optimization, Hospital at home, Uncertainties

1. Introduction

HHC aims to provide medical or paramedical services to patients at their homes. It helps patients to maintain and improve their living conditions, while controlling health system costs, and then reducing the number of occupied beds in traditional hospitals. Although applicable to a wide variety of pathologies, HHC relates more generally to postpartum care, palliative care, and neurodegenerative diseases associated with aging. Thus, partly due to aging of the population, HHC has experienced strong growth in recent years. Taking France as an example, the number of patients using HHC services has increased constantly to reach 128,227 individuals in 2019 (FNEHAD, 2020), with an increase of +266% since 2005. Moreover, in 2018, 11.7% of Gross Domestic Product was spent on Health (INSEE, 2020), among which 1% was spent on HHC (FNEHAD, 2020).

While allowing potential reductions in hospitalization costs, HHC also gives rise to many additional organizational difficulties, compared to a conventional hospital service, as illustrated in Figure 1: patients stay at their homes and may be spread over a wide area, and the HHC agency has to manage several internal mobile resources (mainly human resources with specific skills and constraints) but also some external resources (such as liberal professionals, laboratories, etc.) to provide care to patients at their homes.

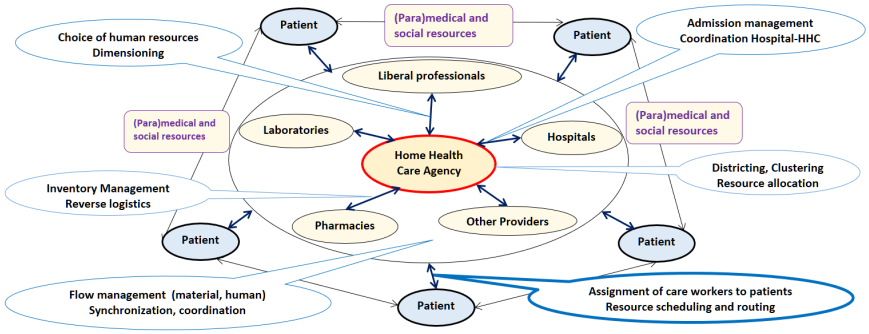

Figure 1: Home Health Care organizational issues

Development of HHC is at the heart of many issues, and raises many questions that

query many disciplinary fields, including the need to lay down norms and standards (Detolle, 2001). This paper focuses exclusively on engineering science aspects. There is a strong need for planning tools, and this is all the more true since in the HHC sector a large number of agencies come from the associative sector (Petrella et al., 2020).

This booming sector is thus opening up new research avenues in the field of industrial engineering and optimization, as illustrated again in Figure 1, highlighting the diversity of these research issues. We can cite, in particular: partitioning of the territory and proper allocation of resources to each district, complying with various criteria (Benzarti et al., 2013); optimization of the admission procedure for new patients coming from hospitals to Home Health Care (De Angelis, 1998), (Koeleman et al., 2012); choice and dimensioning of internal resources (Koeleman et al., 2012); flow and inventory management (Vissers and Beech, 2005); assignment of the various workers to patients (Lanzarone and Matta, 2012); optimization of workers' routes to patients' homes; study of the impact of new patients' admissions on routes.

These problems are scientific issues, characterized by: an inherent uncertainty in the sector (travel time, care duration, evolution of patients' needs, etc.); a wide variety of workers with different skills and constraints (nurse, auxiliary nurse, physiotherapist, etc.); the great importance of the human aspect, which has a direct impact on admission (wishes of the family and patients, etc.), assignment of the care workers (limitation of their number, human compatibility or incompatibility, etc.), the routes (medical and human constraints for schedules); the importance of quality of service (respect for medical constraints, patient preference), which is the primary goal in this sector, even if costs are naturally of great importance.

We focus here on the HHC Routing and Scheduling Problem (HHCRSP). Solving such problems consists in assigning tasks to staff members of the HHC agency, planning visiting hours for a set of patients, and designing the care workers' routes while respecting regulatory and operational constraints.

Some reviews study the existing literature related to the above scientific issues: (Gutiérrez and Vidal, 2013) gives a general overview of logistic problems in the HHC field. Various OR applications are detailed in (Milburn, 2012) and (Sahin and Matta, 2015). An overview of the characterization of the different factors inducing complex-

ity in the HHC context is given in (Sahin et al., 2013). (Becker et al., 2019), gives an overview of approaches using multiagent systems in order to support planning and scheduling in HHC. They analyze 11 papers, published up to 2017, among which only a very few are considering also routing and are in common with our survey. More recently, (Grieco et al., 2020) reviewed the OR approaches and resolution methods used to address the various decision problems in HHC, through a systematic literature review of peer-reviewed papers published up to the end of September 2018. They extracted information (aim of the study, decisions modeled, planning horizon, modeling approach, solution approach, performance aspects, level of engagement with current practice) from 77 non-review papers (70 journal papers and 7 conferences), with the aim of identifying the decision hierarchies, and the OR approaches used in the literature on HHC, clustering papers according to the addressed decisions, and identifying decisions that have been given insufficient attention in the literature.

Other reviews are more focused on the HHC Routing and Scheduling Problem (HHCRSP): Fikar and Hirsch (2017) provided a comprehensive overview of existing works up to 2015 in the field of HHC, focusing on the most common parameters in routing and scheduling problems. In this paper, only journal papers are considered. Later, Cissé et al. (2017) analyzed the literature on OR models applied to HHCRSP (up to 2016) and extended the analysis of Fikar and Hirsch (2017) to other sources of information and other works (like for example delivery of medicine or equipment).

Our purpose here is to identify the constraints and objectives specific to routing and scheduling problems in the HHC context, which have given rise to the development of methods or softwares based on Operations Research (OR) and/or Industrial Engineering (IE) tools. We thus carried out a survey and a bibliometric analysis of the literature, available by mid-May 2019, and identified and structured the decision problems and real-life characteristics. We were more particularly interested in comparing analyzed papers regarding, not only the OR methods and tools used but also real-life characteristics of the solved problems. Since the considered problem is an important issue, which is increasingly emerging under different publication types, journal papers but also conference publications are considered in this paper.

We provide a numerical analysis of the available literature, considering the jour-

nals, conferences, countries of the first author or the application, if present, and the keywords used. We also provide comprehensive tables classifying the papers with detailed information, especially considering real-life aspects. Finally, we observed that there has been a recent increase in the number of papers taking uncertainties and dynamic aspects into account. We thus analyzed these papers more thoroughly to provide their relevant features. To the best of our knowledge, to date no survey has focused on this crucial point.

Note that, during the peer-review process, we conducted a new search, considering papers available from mid-May 2019 to the beginning of November 2020, in order to also include more recent works in our discussions. This new search led to 39 additional papers of interest, among which 24 were published in 2020, and 26 were published in journals. We cite some of them in our discussions, throughout the paper, in order to illustrate some recent trends, but we did not add them to the Tables.

The contributions of this paper are thus as follows:

- A synthesis of the literature dealing with routing and scheduling in the HHC context (numerical analysis and classification of the papers), up to mid-May 2019.

  This synthesis updates the latest review focused on HHCRSP, (Cissé et al., 2017), with 42 additional journal papers and 33 conference papers. Note that, compared to the very recent review by (Grieco et al., 2020), we can say that we limit our study to HHCRSP problems, which appear in their review to be the problem most studied in the literature (59 papers among the 77 studied by these authors), but we also update and extend their HHCRSP problem study. We achieved this by considering several databases (they limited their search to Web Of Science), and also by taking conferences into account (they only considered journal papers and very limited conferences), which led to 153 non-review papers studied.

- A set of comprehensive tables classifying the 153 non-review papers and 12 reviews, published up to mid-May 2019, with detailed information on the publication, the problem studied, the modeling and resolution approach, the tested instances, the objective functions, the constraints related to visits, patients, and staff members.

In comparison to the last major reviews published in the field, (Cissé et al., 2017) and (Grieco et al., 2020), these tables provide a more thorough analysis of the constraints and objectives considered in the papers, focusing on the real-life characteristics of the problems studied.

- Some discussions on current trends in HHC routing and scheduling, observed from the tables and including the analysis of 39 additional papers published between mid-May 2019 and November 2020

- A focus on the uncertain and dynamic aspects, through a table containing detailed information on the kind of uncertainties considered and their modeling, for papers published up to mid-May 2019, but also a discussion including the papers published since then. This subject, which is increasingly attracting the attention of authors, has not yet been considered in a review paper.

- Future research directions, highlighting the aspects that have increasingly attracted the attention of researchers in recent years, and the most promising avenues that are still open.

Such a study will allow new researchers in the field to acquire an overview of the objectives, constraints, and methods used for solving an HHCRSP. They will thus be able to easily position their problem and direct their research towards promising research avenues. As for the decision-makers and planners of HHC agencies, they will easily be able to identify case studies close to their problems, as well as the researchers who studied them.

This paper is organized as follows: Section 2 describes the routing and scheduling problem in HHC and identifies some of the main characteristics of the optimization models presented in the reviewed papers. Section 3 specifies the scope of our analysis and describes the research methodology used in this paper. Section 4 provides some general information from the selected papers, while Sections 5 and 6 classify them according to different objective functions and constraints related to real-life problems. Section 7 focuses on the uncertainties and dynamic aspects: a discussion and future research directions are given in Section 8, while Section 9 concludes this paper.

2. Routing and scheduling problem in HHC

2.1. Description of the problem

In an HHCSRP, we consider a set of patients, spread over a given territory, who need care, for different durations, and requiring specific qualifications, at their homes. Such care is provided by care workers, with different skills and availabilities, managed by an HHC agency. An example of such a problem, with one HHC agency providing care to 15 patients is given in the left part of Figure 2. A time window, corresponding to the patient availability, and a number, corresponding to the visit duration, are assigned to each patient. Weights can be assigned to each arc linking two patients. These weights classically correspond to the distance between two patients or the travel cost. These elements are illustrated only on one arc and on one pair of patients to avoid overloading the figure.

Usually, care workers start traveling from the HHC agency, using diverse means of transportation (mostly a car, but they can also use public transport, cycle or walk) and return there at the end of their working period. However, in some situations, they can start traveling from their homes, or from the first patient of the day to the last one. The HHCSRP consists in deciding which care worker visits which patient, at what time, while respecting a set of various constraints and optimizing some criteria (such as cost or quality of service), over a given horizon. The results are thus a set of routes, indicating the planned visits, as illustrated in the right part of Figure 2, for a case with 4 care workers visiting 15 patients.

This problem is thus similar to the classical and widely studied Vehicle Routing Problem (VRP) (Dantzig and Ramser, 1959). In this problem, the aim is to determine a set of routes, minimizing the total distance or time traveled by a set of vehicles visiting a set of customers spread over different locations. Each customer has to be visited once by one of the vehicles, and the routes all begin and end at a single depot (the HHC agency). Many of the problems considered in this survey can be seen as examples or extensions of VRP, as VRPTW (VRP with Time Windows), in which each customer has to be visited within a given time interval, or other extensions including the multiple depot traveling salesman problem with time windows (MDTSPTW), for example.

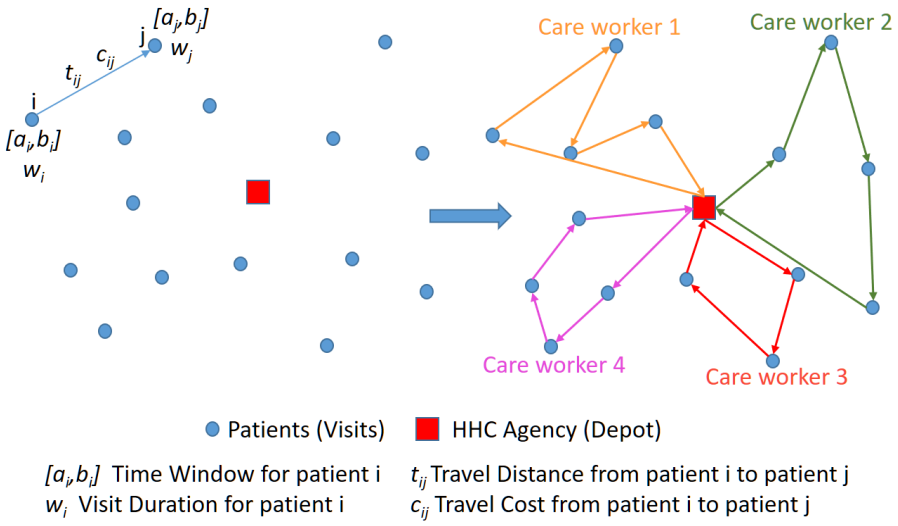

Figure 2: Example of an HHCSRP solution with 4 care workers (K=4) and 15 patients

However, HHCSRP involves some specific features that lead to new constraints and objectives to consider, as we will see in the next section.

2.2. *Main characteristics encountered in HHCSRP*

The specific features encountered in the HHCSRP are the following:

Visits. A given number of visits must be performed by care workers to the patients' homes. A visit is a care for a given patient, performed by exactly one care worker who has the skill corresponding to the needed qualification. A care duration is usually fixed, but it can depend on the care worker's skill in some cases. A patient may need one or more visits during the considered period. When there are multiple visits for the same patient, we may have some temporal dependencies among the visits, which can be more complex than the classical precedence constraints. Indeed, as already defined in (Kergosien et al., 2009) or (Di Mascolo et al., 2014), the dependency between visit times can be (1) a *disjunction*, meaning that two visits to the same patient should not overlap, (2) a *synchronization*, meaning that two visits to the same patient have to start simultaneously or (3) a *precedence*, when several visits have to succeed. This case is usually defined in three ways: (a) *Exact precedence constraints* i.e. one visit

should start immediately at a given time after the end of the other, (b) *Min precedence constraints* i.e. one visit should start at least at a given time after the end of the other and (c) *Max precedence constraints* i.e. one visit should start at most at a given time after the end of the other. We may also have to consider a given frequency for the visits (for example a visit every two days) or a pattern (for example a visit every Monday and Wednesday).

Care workers. Several kinds of care workers are usually considered, with different areas of expertise, as nurses or auxiliary nurses. They are usually represented by different skill levels, and a care worker may only perform tasks corresponding exactly to his/her skill, or a lower skill, in some cases. As already told, all care workers usually begin and end their tour at the Home Health Care Agency, but in some situations, it can be from their homes, or from the first patient of the day to the last one. They can use different transportation means, as a car, public transport, bicycle, or walking. Besides the classical Time Windows constraints representing the availability of the care workers, we may have to respect a set of legislative rules (as a lunch break or maximum working time). Finally, in some cases, we can have some incompatibilities between some care workers and some patients (gender, language, allergy, etc.)

Patients. As in the classical VRP, travel time between patients and between patients and HHC agency is known, sometimes with uncertainties. But in HCCRSP, patients may express preferences for visits regarding, specifically:

- a preference on the gender of a care worker may be associated with a visit; it can also be any other preference or incompatibility with some care workers.
- a desired availability time window (continuous interval) or a preferred day/time can be associated with a visit.
- a continuity of care may be ensured for the patients; this can be a human continuity of care, meaning that, during a period, a given patient always sees the same care worker or a set of preferred care workers, but it can also be a temporal continuity of care, meaning that the patient is always visited at the same time.

These characteristics will lead to models with new constraints compared to the classical VRP. However, there are also differences linked with the considered objective functions. Besides the minimizing of the route cost achieved for the VRP, in HHCRSP, we find various other cost objective functions, considering costs related to care workers (such as minimizing their waiting time or working time, for example), or preference objective functions, aiming at maximizing the preferences of care workers (such as workload balance, for example) or the preferences of patients (continuity of care and other expressed preferences). In the next section, we present a basic model for a VRPTW to illustrate the basis of the models used by most of the papers reviewed. We also discuss some specificities encountered in the HHCRSP context.

2.3. Basic model for a Vehicle Routing Problem with Time Windows

The aim of the VRPTW is to find a set of paths in a network $G = (V,A)$ such that each customer i (*visit in HHCRSP context*) is visited (*performed in HHCRSP context*) exactly once by a vehicle (*care worker in HHCRSP context*) in the time window $[a_i, b_i]$. VRPTW data is as follows (see Figure 2 for an illustration):

- $G = (V,A)$: network where each node $1 \ldots n$ represents a customer (*a visit in HHCRSP context*) and where two dummy nodes 0 and $n+1$ have been added to represent the depot (*HCC agency in HHCRSP context*).
- A time window $[a_i, b_i]$ and a duration of visit w_i is assigned to each node i.
- Each arc $(i, j) \in A$ represents a possible connection between two customers (*visits in HHCRSP context*).
- A distance t_{ij} and a cost c_{ij} are assigned to each arc $(i, j) \in A$. In most papers, this cost corresponds to a travel cost.
- A set K of vehicles (*care workers in HHCRSP context*).

A possible mathematical formulation for this problem is as follows (Cordeau et al., 2000):

$$\min \sum_{k \in K} \sum_{i \in V} \sum_{j \in V} c_{ij} x_{ijk} \tag{1}$$

Subject to:

$$\sum_{k \in K} \sum_{j:(i,j) \in A} x_{ijk} = 1 \quad \forall i \in V \setminus \{0, n+1\} \tag{2}$$

$$\sum_{j:(0,j) \in A} x_{0jk} = 1 \quad \forall k \in K \tag{3}$$

$$\sum_{i:(i,n+1) \in A} x_{i,n+1,k} = 1 \quad \forall k \in K \tag{4}$$

$$\sum_{i:(i,l) \in A} x_{ilk} = \sum_{j:(l,j) \in A} x_{ljk} \quad \forall l \in V \setminus \{0, n+1\} \quad \forall k \in K \tag{5}$$

$$x_{ijk}(s_{ik} + w_i + t_{ij} - s_{jk}) \leq 0 \quad \forall (i,j) \in A \quad \forall k \in K \tag{6}$$

$$a_i \leq s_{ik} \leq b_i \quad \forall i \in V \quad \forall k \in K \tag{7}$$

$$x_{ijk} \in \{0,1\} \quad \forall (i,j) \in A \quad \forall k \in K \tag{8}$$

$$s_{ik} \geq 0 \quad \forall i \in V \quad \forall k \in K \tag{9}$$

With

- $x_{ijk} = 1$ if the arc (i,j) is used by the vehicle k (*care worker k in HHCRSP context*) and 0 otherwise
- s_{ik} is the start time of the visit for customer i (*patient i in HHCRSP context*) when this customer is visited by vehicle k (*care worker k in HHCRSP context*)

Constraints (2) guarantee that all customers are visited exactly by one vehicle (*all visits are performed exactly once by a care worker in HHCRSP context*)
Constraints (3) and (4) ensure that all paths start and finish at the depot (*HCC agency in HHCRSP context*).
Constraints (5) are flow conservation constraints.
Constraints (6) and (7) ensure scheduling feasibility.
Constraints (8) impose binary conditions for the flow variables
and constraints (9) impose positive conditions for the scheduling variables.

Note that constraints (6) can be linearized as:

$$s_{ik} + w_i + t_{ij} - M(1 - x_{ijk}) \leq s_{jk} \quad \forall (i,j) \in A, \forall k \in K \tag{10}$$

with M being a big number.

As mentioned before, in order to model the HHCRSP, several specific constraints must be added. A specificity to be taken into account for the visit, is that there are different types of precedence constraints. For example, in (Bredström and Rönnqvist, 2008), authors propose to introduce an offset variable o_{ij} to model two types of temporal constraints: precedence and disjunction, leading to the following constraints:

$$\sum_{k \in K} s_{ik} \leq o_{ij} + \sum_{k \in K} s_{jk} \quad \forall (i,j) \in V^{Prec} \tag{11}$$

with V^{Prec} being the set of couples (i,j) of visits linked with precedence constraints.

If $o_{ij} = -w_i$, constraint (11) ensures a disjunction between visits i and j.

In the HHCRSP context, it occurs that two care workers are needed for a visit, as getting a heavy person out of bed, for example. This situation can be modeled by two visits i and j linked by a precedence constraint. If the care worker can perform the visit j at any time during the visit i, this situation can be modeled by two constraints (11), one with $o_{ij} = 0$ and one with $o_{ij} = w_i$. For the continuity of care, several models are proposed in the literature. In (Nickel et al., 2012) the notion of patient-nurse loyalty

is introduced. This loyalty represents the number of different care workers that are allowed to perform visits for a patient, and the authors propose to take into account this loyalty in the objective function. In (Yalçındag et al., 2016a), to take into account continuity of care, assignment variables and constraints are introduced.

Note that, in the remainder of the paper, we consider not only Home Health Care problems, as defined above, but we extend our analysis to Home Care or Home Service problems, including also non-medical services aiming at helping elderly and more generally fragile people carry out their daily activities, such as housekeeping, meal preparation, bathing, etc. The reason for that is that Home Care and Home Service agencies face routing and scheduling problems that are similar to those encountered in HHC agencies, the main difference relating to the data. Therefore, in the remainder of the paper, we will use the term "staff member" instead of "care worker", and "visit" instead of "care" or "service", but continue to use the term "patients", even for "beneficiaries" of Home Services.

3. Delimitation and methodology

The process of collecting and selecting analyzed papers performed to define our paper database is described step by step in Figure 3. First, we define a list of relevant keywords used for the database search. Different possibilities of "Keywords Combinations" are tested over the four databases classically used in the area of OR and IE, namely Scopus, Web Of Science (WOS), Google Scholar, and ScienceDirect. The keywords are relatively generic to avoid missing any relevant papers. The keywords combinations considered in our search are the following:

(Home care AND Routing) OR
(Home care AND Scheduling) OR
(Home health AND Routing) OR
(Home health AND Scheduling) OR
(Home service AND Routing) OR
(Home service AND Scheduling) OR

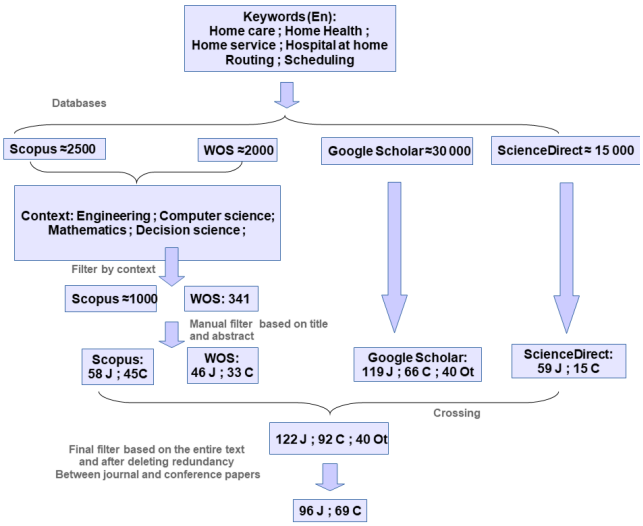

Figure 3: Bibliography research scheme

(Hospital at home AND Routing) OR

(Hospital at home AND Scheduling).

The initial search did not use any limitation and resulted in a large number of papers in English for each database, that is why a first limitation by context (engineering, computer science, mathematics and decision science) is introduced for the first two databases. Note that context limitation is not available for Google Scholar and ScienceDirect databases, thus all resulted papers were browsed one by one and selected by reviewing the title, keywords, and abstract. This is also the case for the second filter applied to the other databases after the context filter.

Then, the resulted papers were crossed and 3 categories were distinguished, namely: journal papers (J), conference papers (C), and others (Ot) including book chapters, technical reports, and Ph.D. thesis. We decided to keep only journal and conference papers, and all of the promising papers were then analyzed using a full-text review. To consider a paper as relevant, several criteria must be met.

The first criterion is a focus on HHC i.e. the purpose and objectives must explicitly address HHC concerns. Indeed, we restrict our survey to problems in which staff members deliver cares or services to patients, and thus spend some time at each home;

this leads to the exclusion of some papers considering routing for pickup and delivery problems in HC agencies, such as (Liu et al., 2013), or (Shi et al., 2018), for example, which are taken into account in (Cissé et al., 2017) and (Grieco et al., 2020).

The second criterion focuses on papers that address routing and scheduling problems within an HHC context. This leads to the exclusion of some papers talking about HHC as a potential application, among others, of a generic routing and scheduling problem they are solving, such as (Parragh and Doerner, 2018) for example, but also the exclusion of some papers dealing with problems in the context of HHC, but considering mainly resource dimensioning, such as (Regis-Hernández et al., 2019), or only assignment, such as (Nasir et al., 2018).

The last criterion is redundancy, i.e. conference papers that have been published in a journal paper later are ignored. To be more accurate, we found 21 such redundant conference papers, which are only considered when studying the general characteristics, in section 4, and are omitted in the tables.

We eventually end up with 96 journal papers (J) and 69 conference papers (C) to analyze, i.e. 165 papers, from 1997 to mid-May 2019. More specifically, the 96 journal papers include 6 review papers (representing 6%), the 69 conference papers include 6 review papers (representing 9%) which leads to 90 journal papers and 63 conference papers (i.e. 153 papers which are not review papers).

All conferences not being present in the used databases, we cannot guarantee to have an exhaustive view of the conference papers, however by listing the conference papers, our objective was to highlight the latest trends. Note that the list of papers obtained using this methodology includes all the papers studied in (Cissé et al., 2017) and (Grieco et al., 2020), and which are within our scope.

We analyzed all these papers in order to extract information of interest. The following sections show this content analysis by using tables, which present quantitative outcomes resulting from the reviewed papers related to HHC routing and scheduling literature.

All the tables can be found at the end of this paper. We chose to separate tables dealing with journal papers from tables dealing with conference papers, however, the tables dedicated to conference papers also include global sums and proportions, ob-

tained considering all the 153 papers (or 165 when considering the type of paper in Table 4), thus ignoring if they come from journals or conferences.

In all the tables, when a paper tackles one of the mentioned characteristics, a symbol ($\surd$) is displayed in the corresponding cell, and the total number of papers considering each characteristic and each subgroup (sum), and their proportion (%), are given. Note that the proportion is calculated considering 91 journal papers and 63 conference papers, except for the type of paper, for which we took into account also the reviews, considering thus 96 journal papers and 69 conference papers. In these tables, we added some sub-sums and sub-proportions, calculated for subsets of characteristics, by counting the papers that show at least one of the characteristics present within the set: if we take Table 6 as an example, the sub sum "SM cost" considers all the papers having at least one $\surd$ in columns "min total visit duration", or "min waiting time", or "min overtime", or an "SMi" in the column "others".

In each of the following sections, we study and comment on the content of these tables. However, in order to reach a more general conclusion than the one obtained examining the tables one by one, we also conducted a complete study of the obtained values, by crossing the tables. We especially observed more closely the common characteristics between the papers presenting case studies on the one hand, and more theoretical papers on the other hand. We also observed the evolution of some characteristics of the problems over the years.

4. General characteristics - Tables 2 to 5

This section is devoted to the presentation of the content analysis enabling us to extract some general characteristics about the publication (year, journal, authors, keywords), the studied problem, the proposed tools, and solutions. We thus propose a quantitative evaluation of the general characteristics of the papers, based on the detailed information about the publications (references, journal or conference title, the affiliation of the first author, country for the application), the studied problem (the type of study -case study or review, the other being more theoretical papers-, horizon, presence of uncertainties in the studied problem), the modeling and resolution approaches,

and the instances used for numerical tests, displayed in Tables 2 and 3, for journal papers, and Tables 4 and 5 for conference papers. In Section 4.1 we also considered the 21 redundant conference papers, which are not reported in the tables.

4.1. Information about the publication

Evolution of the number of publications over the years. Analyzing the journal papers' publication year, we found that the first publication about routing and scheduling in HHC appeared in 1997, with the work of Begur et al. (1997), but there are few papers up to 2011 (zero, one or two per year). Since then, the increase in the number of papers addressing HHC routing and scheduling is significant, especially in recent years (see Figure 4): we found 17 journal papers in 2018, representing an increase of 76.5% compared to the 4 papers published in 2011. Note that, for the first 4 months of 2019, there are already 15 papers, which shows that the number of papers is still significantly rising.

If we analyze now the conference papers (see Figure 5, where the redundant conference papers are represented in a lighter color), we observe that the first publication appeared later (in 2006), and their number increased, since then, but less regularly than for journal papers.

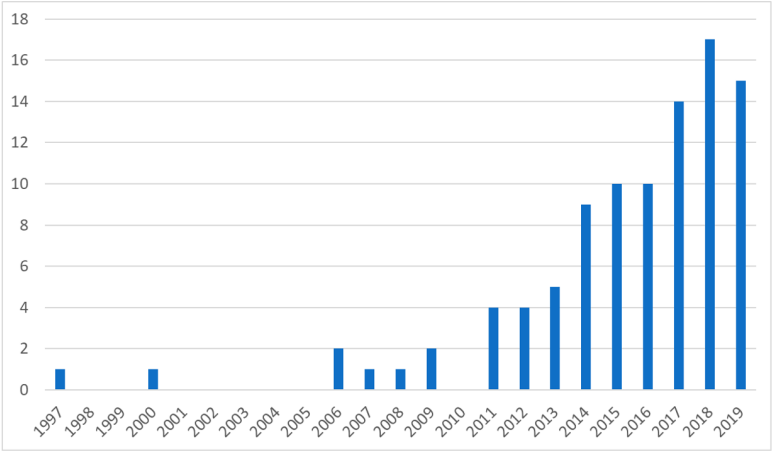

Figure 4: Evolution of published journal papers over the years (only up to mid-May for 2019)

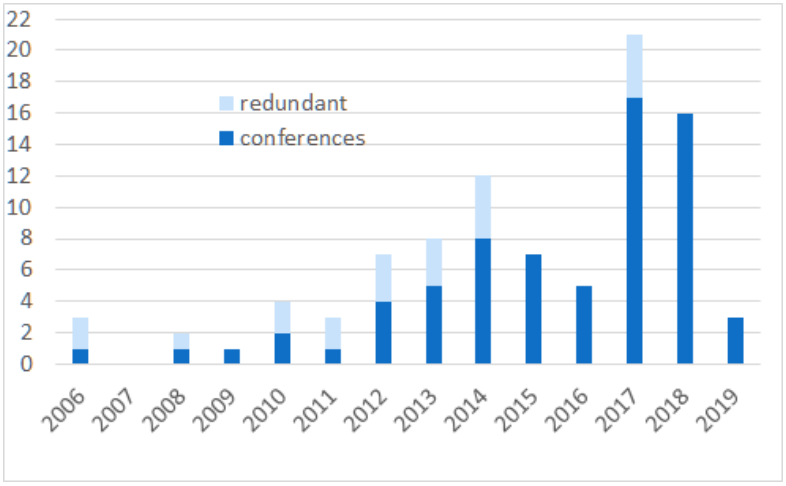

Figure 5: Evolution of conference papers over the years (only up to mid-May for 2019)

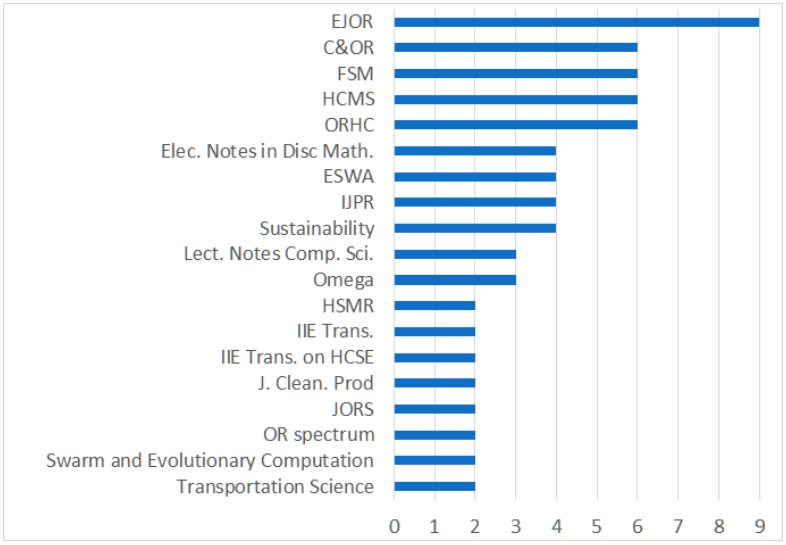

Figure 6: Journals with at least 2 publications

Most common journals/conferences. The problem of routing and scheduling in HHC has received a lot of interest and has been presented in several journals, and several national and international conferences around the world.

Figure 6 shows the 19 journals with at least 2 publications in the HHC context. We can note that the journals with the highest number of publications are in the fields

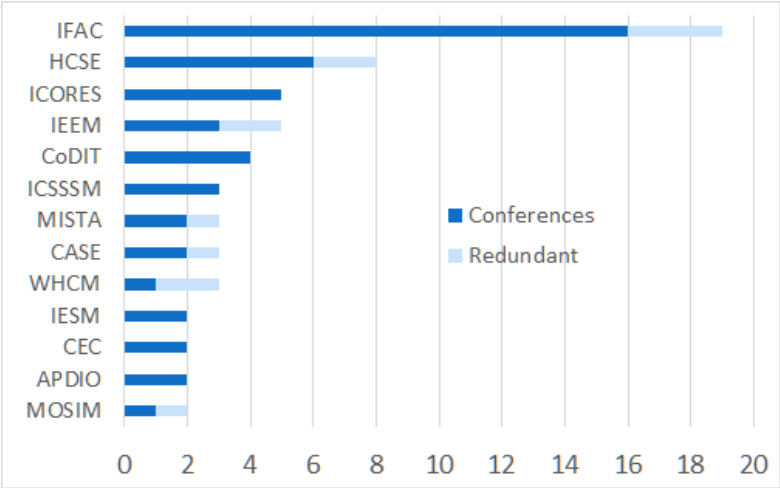

Figure 7: Conferences with at least 2 publications

of Operations Research, Manufacturing and Production Research, Computer Science, Mathematics, or more focused on Health Care. In addition to these 19 journals, there are 26 other journals, dealing with various subjects, which received only one publication.

Figure 7 shows that, among the 14 conferences with at least 2 publications, most conference papers are published in the fields of Automatic Control, Health Care Engineering and Management, Operations Research, Industrial Engineering, Engineering Management, Decision, or Scheduling. Here again, we observe a great diversity of topics and conferences, most of them (29) receiving only one publication in the HHC context.

Most commonly mentioned keywords. We are interested here in the main topics in the field of HHC routing and scheduling based on selected authors' keywords of reviewed journal and conference papers. We found a total of 244 different keywords, most of them (160) appearing only once. Only a very few of them appear 10 times or more (9). They are rather general keywords concerning the studied problem (home health care or home healthcare, home care, scheduling, routing, vehicle routing, optimization, routing, and scheduling) and the general methods used (metaheuristics, heuristics). If

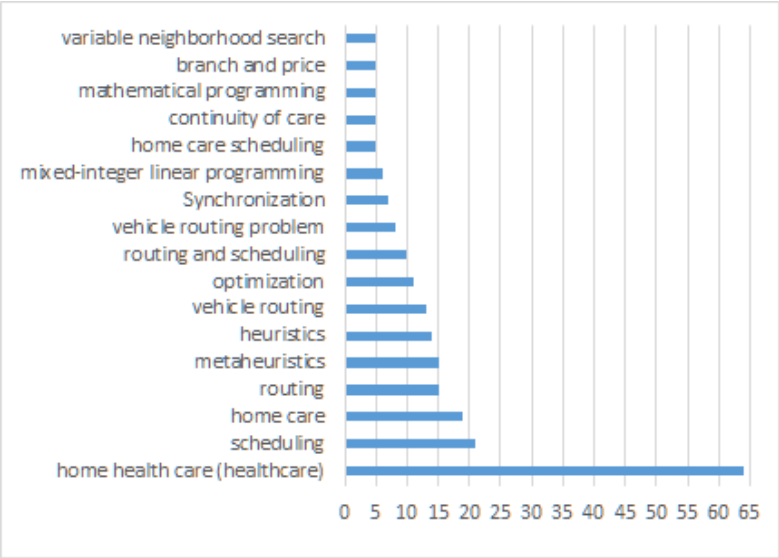

Figure 8: Most common keywords

we consider now the 8 keywords appearing between 5 and 9 times, we observe some general variants of the studied problem (vehicle routing problem, home care scheduling), some methods (mixed integer linear programming, mathematical programming, branch and price, variable neighborhood search), but also some characteristics of the problem (synchronization, continuity of care). Figure 8 shows the keywords that were found more than five times in journals and conferences papers.

Country of authors' affiliation and application. We discuss here the country of affiliation of the first authors, as well as the country of application for case studies related to HHC. Figure 9 shows that the HHC problem concerns the entire world (30 different countries), and mainly Europe, China, and the USA. We can notice that most journal papers are written by first authors coming from France (15), China (11), Austria (10), Italy (8), USA (8), Germany (7), and UK (7) (for the countries having 5 or more publications), and mostly contain applications from Austria (5), Italy (5), China (4), France (3) and USA (3).

For publications in conferences, most papers come from France (30), Portugal (8) and Italy (7), with, again, an interest from the entire world (20 different countries,

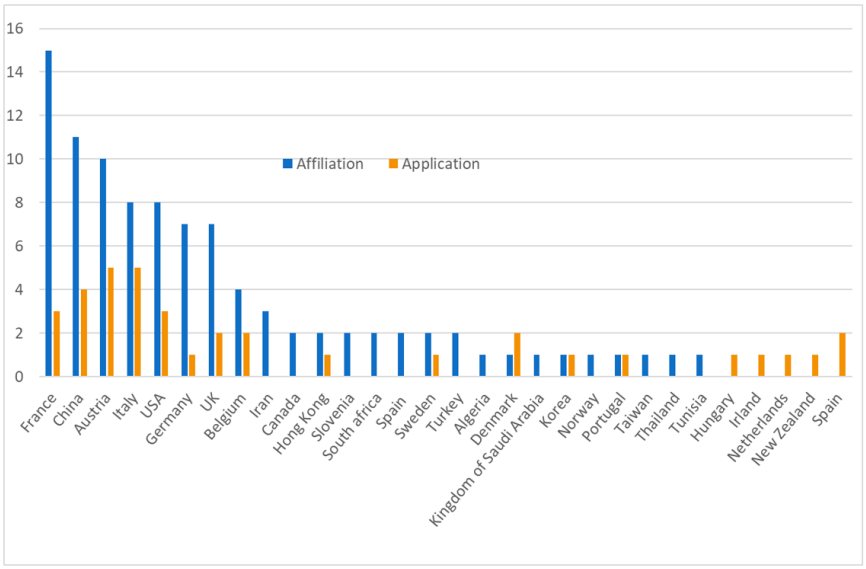

Figure 9: Analysis of authors affiliation and/or country of application for journal papers

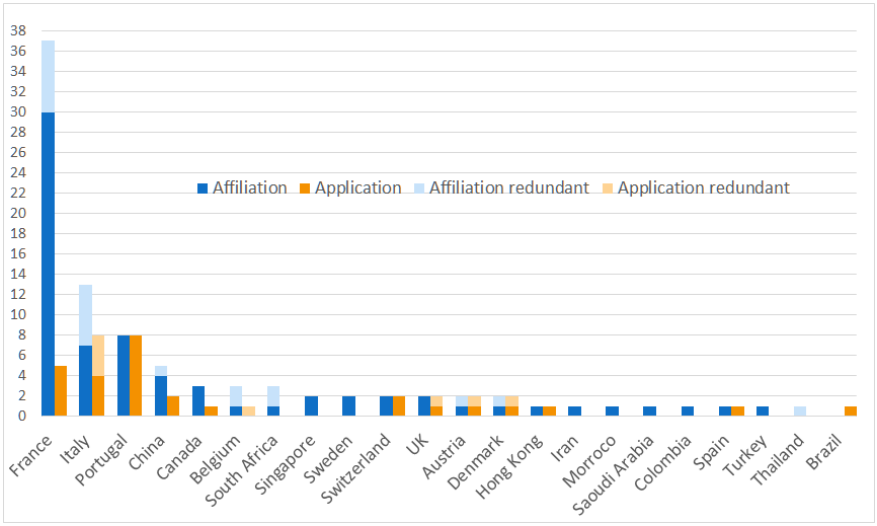

Figure 10: Analysis of authors affiliation and/or country of application for conference papers (redundant papers are lighter)

many of which (11) having only 1 communication). Note that new countries appear, compared to those observed in journals, such as Switzerland, Colombia, Morocco etc.

4.2. Studied problems

Work methodology. From Tables 2 and 4, about 6% of the analyzed journal papers and 9% of the conference papers are literature reviews, whereas 39% of the journal papers and conference papers are dealing with case studies: a paper is classified as a case study if the problem is tested on real-life instances provided by an HHC agency. We can note that half of the case studies have been published in the last 4 years.

Hence, the problem is a topical problem for both researchers and health professionals.

Planning horizon. In HHC, the planning can be carried out on a short term (one day or less) or a long term horizon (more than one day, usually one week, for most of the papers, but sometimes several weeks). Table **??** shows that, as far as journal papers are concerned, there is slightly the same number of studies dealing with the short horizon (52%) or the long horizon (48%), whereas, for conferences, we observe that the papers dealing with the short-term horizon are more numerous (65%). Note that, when we focus on the papers published since the last review, we observe that there have been more papers considering a long term horizon.

Note also that, when we focus on the case studies, we observe that most studied problems are dealing with a long term horizon, especially since 2017, which is coherent since, in real life, patients need more than one visit.

Uncertainties and dynamic aspects. The majority of analyzed papers (72%) are dealing with static cases. However, since 2014, stochastic and dynamic aspects are more and more present in the research in the HHC field (note that more than half of the papers dealing with uncertainties and dynamic aspects have been published since 2017, in journals as well as in conferences, and represent around 40% of the papers published since then). That is why we are focusing on this aspect in Section 7.

4.3. Proposed approaches and experimentations

Proposed solution methods. Tables 3 and 5, presenting detailed proposed solution methods, show that a wide variety of methods has been developed. These methods,

which are often used for Vehicule Routing Problems (VRP) or Workforce Scheduling and Routing Problems (WSRP), in general, can be exact methods (as Branch and Bound or Branch and price, for example) or approximation ones, including dedicated heuristics, or a large panel of metaheuristics (ranging from Tabu Search to population-based methods as Particle Swarm Optimization, for example, or, more recently, Ant Colony Optimization), or methods based on linear programming (like matheuristics for example), or hybrid methods, combining several methods (like Constraint programming and Tabu Search, for example).

Note that most papers propose a linear model and often test it using linear solvers such as Cplex, and, as far as conferences are concerned, there are many cases for which only a mathematical model is proposed (20 conference papers out of 63), metaheuristics being often proposed in other cases.

We can also observe that, globally, methods proposed before 2014 were more often based on greedy heuristics and local research procedures. However, since, 2015/2016 more advanced methods, such as benders decomposition or hybrid methods, are increasingly being considered. We also note that, for case studies, two-phase resolution methods are widely used for their simplicity and facility of adaptation for most combinatorial problems such as the case of HHC routing and scheduling.

In the latest published papers, we notice a growing interest for modified Ant Colony Optimization algorithms (Decerle et al., 2019a; Euchi, 2020; Martin et al., 2020; Inanç and Şenaras, 2020). In (Fathollahi-Fard et al., 2020), the Social Engineering Optimization is applied to solve the HHCRSP for the first time, according to its authors.

Tested instances. Used instances are also an important point and show the problem consideration in real life. The instances can be benchmarks that already exist in the literature, either for general VRP problems, like (Solomon, 1987), or for HHC scheduling problem, like (Bredström and Rönnqvist, 2008), or random instances generated by the authors (sometimes based on real data), or real-life instances provided by HHC agencies (case studies). We notice that only a few works (20%), almost all of them considering daily planning, use instances from the literature and that almost every author uses his/her own instance. These instances are most often randomly generated ones (58%)

rather than real instances from HHC agencies.

Finally, for the papers where it was explicitly specified, the size of the used instances was also retrieved in the tables. The considered size varies a lot from one paper to another. We can note that the instance sizes are usually larger when considering case studies or journal papers, rather than theoretical cases, or conference papers.

After this global description of the papers, we now focus on the detailed characteristics of studied problems in the analyzed papers, namely the objective function and the considered constraints.

5. Objective function - Tables 6 and 7

We identified around 30 different criteria that we divided into two categories, namely costs and preference. For each category, we have sub-categories (Route, Staff Members, Patients) and the columns of tables 6 and 7 show the criteria appearing at least three times. The criteria appearing only once or twice are listed in columns named "Other" and are named SM, if they refer to Staff Members, C, if they refer to Cost in general, Pa, if they refer to Patients (details are given at the bottom of table 7). Note that, recently, a few additional criteria which are neither cost, nor preference criteria, appeared; they are linked with disruptions - minimize response time to disruptions (Du et al., 2017b)-, clustering - minimize total number of clusters (Quintana et al., 2017), or maximize clustering efficiency (Mutingi and Mbohwa, 2014) -, or environmental pollution (Fathollahi-Fard et al., 2018a), and appear each only once. They are named O in the tables.

The research conducted on articles published after May 2019 showed that sustainability is getting more attention lately (Ros-McDonnell et al., 2019; Quintanilla et al., 2020). In (Cinar et al., 2019), a new criterion is studied: they maximize the global priority of the visited patients, who are ranked depending on then their condition, their dependency and the last time they were visited.

In the tables, the sub-sums and sub-percentages for patients and staff members are

calculated by including the criteria SM or Pa appearing once or twice and placed in columns "Other".

5.1. Cost optimization

We identified more than 10 different cost optimization criteria (see tables 6 and 7), and observed that 90% of the studied papers consider at least one cost criterion. We summarized below the most frequently considered ones:

- **Route costs (77%)**

  minimize travel time/cost/distance (76%)

- **Staff member cost (42%)**

  minimize overtime costs (15%)

  minimize visit duration/working time (14%)

  minimize waiting times (13%)

We observe that the minimization of travel costs, distances or travel times is considered by almost all the authors, whether in journal or conference papers, which is not surprising since it is a standard criterion for the VRP problem and also a real concern for HHC agencies. However, there are also several papers considering costs related to staff members, which are more specific to HHC routing and scheduling problems. Note that journal papers mostly consider the minimization of overtime cost, whereas conference papers deal mostly with the minimization of visit duration/working time.

5.2. Optimization of the quality of service and well-being at work

Preference criteria are a very important point in improving quality of service and well-being at work for HHC agencies but are less present than cost criteria (58% of the studied papers consider at least one preference criterion). They can be divided into two types, namely patient and staff member preferences. We summarize below the most used preference criteria, among the identified ones (more than 15 different ones):

- **Patient preferences (48%)**

maximize patient preferences (16%)

minimize TW violation (12%)

minimize uncovered visits (11%)

maximize continuity of care (10%)

- **Staff member preferences (19%)**

  balance workload (17%)

As far as patient preference is considered, most journal contributions consider the minimization of uncovered visits, which is not present at all in conferences. Note that, when this objective function is not present, it means that we have a constraint ensuring that all the visits are covered. Another important criterion for both journal and conference papers is the maximization of patient preferences, related to the appreciation level of the assigned staff member. Generally, a patient assigns a score to each staff member, and this last is strongly desired if he/she has a high preference score. Criteria related to the minimization of non-respect of soft time windows are also considered in many papers.

Note that the continuity of care, which is very important in real life, has known less interest in the literature when considering both criteria and constraints (as seen also in section 6). This criterion often results in assigning the same staff member to a patient, or, otherwise, minimizing the number of different staff members over the horizon, and usually complicates a lot the problem. Finally, we can note that some criteria appear only once or twice, and especially in recent conference papers.

The second preference category concerns the staff members and is mainly measured by balancing the workload. A few papers also consider the clustering efficiency, which could be found as avoiding the assignment of staff members far from their area, or the region priority, which means that a staff member has a preference for working in some zones, and the model should maximize this preference.

5.3. Discussion on the objective function

Criteria. Since almost all the analyzed papers model the problem of routing and scheduling in the HHC context as an extension of the VRP, travel criteria are almost always

considered. However, most of the papers consider a multiple-criteria objective (almost all from 2 to 4, one journal paper considering 7 criteria, one conference paper considering 5 criteria, and one conference paper considering 7 criteria). Note that 34% of the studied papers consider only one criterion (which is cost, for 81% of the cases with only one criterion, 35% of the papers consider 2 criteria, 19% consider 3 criteria, and 12% consider 4 criteria. Note also that in many cases (55%), the objective functions include both cost and preference criteria, but there are many studies considering only cost criteria (37%) or only preference criteria (8%).

Multi-objective function vs mono-objective function. As seen above, most papers (66%) consider at least 2 criteria in their objective function, which is usually expressed as a weighted sum of several criteria. It is only from 2015 that we can find some papers considering several objectives, without aggregating them, and using thus multi-objective resolution methods. For the short-term planning, we can cite (Ait Haddadene et al., 2016b) and (Braekers et al., 2016) who have studied the trade-off between minimizing travel costs and maximizing the preference of patients in home care agencies, by proposing methods based on the ε-constraint approach and enumerating the Pareto Frontier, or, more recently, (Decerle et al., 2019b), who used a memetic algorithm to obtain the Pareto front for three objective functions: minimizing the total working time of the staff members, maximizing the quality of service, and minimizing the maximal working time difference among nurses and auxiliary nurses. For multiple period cases, we can cite (Rodriguez et al., 2015) who have studied the trade-off between minimizing travel costs and maximizing the staff members workload, by proposing an approximate Pareto frontier, or (Liu et al., 2018), who generated approximate Pareto fronts with three heuristics approaches in order to find a trade-off between cost and preference criteria.

Evolution through the years. Now, if we observe the evolution of the studied criteria through the years, we note a growing diversity of criteria over the years, and especially since 2017. The very clearly dominant criterion remains, all over the years, the classic objective function used for a VRP: Min travel time/cost/distance, but the proportion of papers considering this criterion has slightly decreased since 2017. The second

one is patient's preference, which has known a very significant increase since 2017, especially as far as journals are considered. For conferences, we also observe that the staff member cost is considered in many papers since 2010. More generally, we can say that preference criteria, although not insignificant since 2006, and increasing since 2017, are still clearly dominated by the cost criteria. Moreover, more recently, as already mentioned above, we also observe some criteria which are neither cost nor preference but are linked to environmental considerations, clustering or disruptions.

Case studies vs theoretical papers. If we compare the criteria used for case studies and those used for more theoretical papers, table 1 shows no specific particularity. We can however note that the criteria "max continuity of care" or "min reassignment" are studied in only 4% and 2% of the theoretical journal papers, whereas we can find them respectively in 13% and 8% of the case studies. The criteria concerning patient preference are studied in a larger proportion of papers, whether case studies or theoretical studies (47% and 36% respectively) than staff member preference (19% and 21% respectively). In general, a greater proportion of papers are concerned with cost optimization compared to the optimization of preference criteria, but the proportion of papers that focus on preference criteria is far from being negligible, for theoretical papers (58%) or case studies (43%). In conference papers, we observe that, in the case studies, a significant proportion of papers (22%) optimize the criterion Max continuity of care, whereas only 5% of theoretical papers consider this criterion, which corroborates what has been observed for journals; finally, we note that authors give more attention to the patient and staff member preference in case studies (41% and 33%) than in theoretical papers (35% and 14%).

6. Constraints - Tables 8 to 13

We now present the various constraints considered in the analyzed papers, that we have chosen to divide into three categories: those related to visits, those related to patients, and those related to staff members. Each category of constraints is presented in a separate table. Note that in the following, we summarize the most considered

Table 1: Criteria comparison between real cases and theoretical papers (percentages of each subgroup)

Objective function	Journal papers		Conference papers	
	Case Study	Theory	Case Study	Theory
Route costs	79%	75%	70%	78%
Staff member costs	39%	43%	33%	27%
COSTS	**79%**	**66%**	**89%**	**92%**
Patients preference	47%	36%	41%	35%
Staff members preference	19%	21%	33%	14%
PREFERENCES	**58%**	**43%**	**63%**	**49%**

constraints, indicating the proportion of papers containing at least one constraint of the considered type.

6.1. Constraints related to visits - Tables 8 and 9

These constraints are present in 90% of the studied papers and are split into three categories, namely general characteristics, schedule, and dependency. General characteristics mainly include time windows, which can be hard, or related to the production of a certain product (as for chemotherapy at home); required qualification level, which is an important feature. The schedule can be defined by the number of required visits per day, or over the planning horizon, and this by assigning a frequency to each visit, or by a combination of desired visit days named patterns, for example (Monday, Thursday) in a case where two visits are desired. The dependency between visit times can be disjunction, synchronization, exact precedence, or min/max precedence, as explained in section 2.2. Finally, some other criteria, appearing only once or twice, are listed in the column named "others".

Thus, from Tables 8 and 9, whose information is summarized below for the most used constraints, it is clear that most considered constraints are time windows (including hard time windows (66%)), followed by the qualification required. However, constraints related to the dependency and/or the frequency of visits are of less interest but remain significant in the HHC context. Papers published very recently both in journals and conferences confirm this trend (Euchi et al., 2020; Hashemi Doulabi et al., 2020; Nozir et al., 2020; Shahnejat-Bushehri et al., 2019).

- **Temporal constraints (71%)**
  - Time windows (69%)
  - Dependency (25%)
- **Assignment constraints (73%)**
  - Qualification required (58%)
  - Schedule (33%)

6.2. Constraints related to Patients - Tables 10 and 11

These constraints are less considered in the literature (46%) than those related to visits (90%) or staff members (82%) and are relatively recent. Temporal constraints are very varied but often considered as soft constraints; we can mention precisely soft time windows -representing time windows which are preferred by the patients for receiving some cares-, preferred starting time, or preferred day of visits, etc. They are not often taken into account, but it can be seen that these constraints are more present since 2014, so it is highly probable that they will be widely studied in the years to come.

Continuity of care is defined by assigning, for example, the same staff member throughout the period, or visiting the patient at the same hour each time. Even though these constraints are very important in improving the service quality of HHC agencies, they have rarely been taken into consideration by research and also in real life before 2014, but have been knowing a growing interest, especially since 2018. Continuity of care is most often taken into account by assigning the same staff member throughout the period, especially in journal papers, but we also observe other ways to deal with continuity of care, as assigning the same time slot to visits, or a preferred staff member, or pre-assigning a staff member, or, more recently, considering loyalty to a staff member. Note that when we consider both objective function and constraints, we observe that 31% of the 153 studied papers deal with continuity of care, either as an objective function, or as a constraint, or both.

In our last bibliographic update (from mid-May 2019 onwards), we did not find any significant changes in the trends regarding constraint related to patients.

- **Temporal constraints (25%)**

    Soft time windows (13%)

- **Assignment constraints (29%)**

    Continuity of care (29%)

6.3. Constraints related to Staff members - Tables 12 and 13

Staff member constraints are present in 82% of the studied papers and can be divided into several categories, namely characteristics (including skill level and availability - which includes hard time windows, common in journal and conference papers, but also soft time windows or soft breaks), rules (which are mostly the legislative rules, according to the number of working hours per day and per week, lunch breaks... Other rules can be listed, as additional work, related for example to the meetings in the HHC agency, but they are very rarely considered), district/region, incompatibility with a patient (when for example a patient requires a gender (male/female) or the staff member can refuse a visit if for example he/she has allergies for some animals which can be present at the patient's home), and transport. Some transportation mode constraints have appeared in some journal papers. In fact, the most often used transportation mode is a personal vehicle, nevertheless, some authors have been interested in using public transport, such as Rest and Hirsch (2016), or sharing vehicles, or walk, such as Fikar and Hirsch (2015), or, for a few of them, considering multi-modal transportation, by combining two or more transportation modes, such as Hiermann et al. (2015), who combine public transport and car. In (Quintanilla et al., 2020), doctors and nurses share taxis and travel together. New strategies of transportation are studied, such as walking and changing during the route the sets of workers who travel together.

The most often encountered constraints are the following:

- **Temporal constraints (58%)**

    Hard time window (48%)

- **Assignment constraints (55%)**

Skill level (55%)

- **Rules (49%)**

  Legislative rules(39%)

- **District region (13%)**

6.4. Discussion on the constraints

We observe that the studied problems often deal with generic constraints usually considered in VRP, and illustrated in section 2.3, such as time windows, dependencies between visits, skill level, in journal papers, as well as in conference papers. Some of these characteristics are less present for case studies, as time dependencies. Note also that, for case studies, we find more constraints about visit frequency as well as legislative rules, types of used vehicles, and continuity of care.

If we consider now the evolution of the constraints through the years, we observe that, for journal papers, the proportions have been slightly the same since 2017, except for the continuity of care, which increased significantly. For conference papers, we observe also a decrease for constraints considering precedence.

7. Focus on the uncertainties and dynamic aspects - Table 14

7.1. Motivation

In most of the above-mentioned papers (72%), all parameters are assumed to be known in advance, whether it is travel times, visit times, patients' availabilities, etc. However, in practice, it is highly unlikely to conduct the planned schedule throughout the whole horizon without any disruption. In HHC, the data is subject to a high variability due to the inherent uncertainties of the area, which often lead the original schedules to be unfeasible. Since the human factor is predominant in this domain, some constraints make it impossible to simply cancel impacted tours, or recompute optimal tours whenever a new event occurs. Therefore, it is obvious that the deterministic problem is not entirely suited to real-life unpredictabilities.

Furthermore, HHC agencies constantly face staff turnover or changes in the pool of patients. In this case, again, recomputing optimal tours with the new data might not be completely satisfying due to continuity constraints: they need to deal with a re-planning problem. Whether on a strategic, tactical, or operational level, considering uncertainties and dynamic aspects appears to be necessary to offer practical solutions to the home health care routing and scheduling problem.

We examined and classified 37 papers, including 25 journal papers and 12 conference papers among the 43 papers showing an interest in uncertainties or dynamic aspects. We chose to ignore the papers dealing with uncertainties not related to delivery of cares, such that fuzzy demands in papers where a pick-up and delivery problem is jointly addressed with the scheduling and routing problem. It led to the exclusion of (Shi et al., 2017a), (Shi et al., 2017c), (Tohidifard et al., 2018) for example. We also eliminated some papers, such as (Carello et al., 2018) and (Yuan et al., 2014), which are extensions of previous papers by the same authors (respectively (Carello and Lanzarone, 2014) and (Yuan et al., 2015)) considering different nominal problems but bringing no new contribution to the methods they propose regarding the handling of uncertainties since they use the same method in the extensions than in the original papers.

The new search we conducted to cover papers published after May 2019 provided 7 additional papers. Even though they are not included in the numerical data that we give, they do not run counter to our global analysis unless stated otherwise.

The interest in uncertainties is quite recent since the oldest paper that we consider dates back to 2011, and 68% of the selected papers were published from 2017 onwards.

7.2. Types of uncertainties

As previously mentioned, in the HHC context, uncertainties have different causes, thus they take different forms. First, they can stem from the patients who may require a change in the frequency of their visits (Mosquera et al., 2018) or in their assigned time

slot (Lin et al., 2018). They may also have new demands or cancel their planned visits (Yuan and Jiang, 2017). Sometimes one-time cancellations occur (Gunawan et al., 2017), but at other times, the patient is simply getting out of the system because his/her health declined and he/she had to be hospitalized (Gomes and Ramos, 2019).

Staff members also bring their own unpredictability: when staff members are on sick leave, take a day off, or change their availabilities during the horizon, their whole tour is impacted even though the patients who were scheduled need to receive the planned visits anyway (Xie and Wang, 2017). Six papers, (Bennett and Erera, 2011), (Demirbilek et al., 2018), (Demirbilek et al., 2019), (Nasir and Dang, 2018), (Nasir and Dang, 2019), (Nguyen and Montemanni, 2016), take into consideration the admission of new patients, or the possibility of hiring new staff members, therefore adding another decision to the initial scheduling and routing problem.

Finally, there are uncertainties that are deeply bounded to the HHC field with uncertain visit times (Demirbilek et al., 2019; Zhan et al., 2020), to the health sector with emergencies or real-time demands (Ouertani et al., 2019), or to routing problems with uncertain travel times (Nikzad et al., 2020; Shi et al., 2019). We aggregated the considered uncertainties or perturbations in three categories:

- Changes related to demands: 65%
- Changes related to patients: 43%
- Changes related to staff members: 22%

Note that changes related to patients and demands can be closely linked, but we separate them according to the following criteria: if the change impacts only one visit or one type of visits, then we categorize it in the demands' category. If the change concerns all the visits required by the same patient during a period, then it is in the patients' category. We consider that cancellations of visits often happen for a full period (day, week, permanent departure), therefore we put it in the patients' category.

Among all criteria, uncertainty in visit times is the most studied: 44% of selected papers consider it. Then, we find the changes in the pool of patients (new patients 28%

and departure or cancellations of patients 25%), travel times (25%), closely followed by new demands (22%). On the contrary, some criteria are marginal: changes in visit frequencies (Mosquera et al., 2018) or broken vehicles (Alves et al., 2018a) are only considered in one paper each.

Among the 7 papers published after May 2019, uncertain visit times are considered in 5 of them, and uncertain travel times in 4 of them.

7.3. Approaches

There are different ways to handle uncertainty : robustness (13%), flexibility (10%), stochastic optimization (32%), dynamic optimization (32%), stability (13%) etc. These approaches are not necessarily incompatible, and they do not offer the same possibilities for the decision-maker.

A first strategy consists in forecasting the contingencies and providing a robust solution, that is to say, a solution that stays feasible in spite of disruptions. The robustness of such a solution depends on the degree of conservatism of the solving approach, i.e. the degree of risk the decision-maker is willing to take. For instance, Naji et al. (2017) offer an extremely conservative solution that would remain feasible in any considered scenario. By comparison, in (Cappanera et al., 2017) and (Carello and Lanzarone, 2014), the feasibility of the solution is only guaranteed for scenarios with a controlled amount of disturbance. In (Shi et al., 2019), the solutions remain feasible as long as service and travel times vary within predefined intervals.

Flexible parameters also give more possibilities in the creation of a schedule: in (Mosquera et al., 2018), the visit times and frequency of the visits are adjustable; in (Nasir and Dang, 2018), the possibility of hiring nurses and accepting new patients is offered; in (Restrepo et al., 2019), the decision-maker can ask staff members on rest days to come back to work, etc.

These models make it possible to anticipate the disturbances, thus they are mostly used at a strategic or tactical level.

To deal with uncertainties on the operational level, other strategies are used. They

could be qualified as "corrective" strategies: an original schedule is built, and whenever a contingency occurs, we proceed in the alteration of the initial schedule. This dynamic approach offers the advantage of only taking into account the disruptions that actually occur, and thus the solution remains optimal as long as there are no uncertainties. However, the corrections may be extremely expensive or completely inefficient. In (Kandakoglu et al., 2020), floating nurses can replace absent nurses on short notice. Dynamic problems can be handled with a stability objective, which consists in staying as close as possible to the initial schedule: it offers a continuity highly appreciated by both staff members and patients. In (Yuan and Jiang, 2017) for example, the stability is maximized for all stakeholders: the patients, the staff, but also the company. Starting and ending times or assignment of staff members are the main criteria of stability.

It is to be noted that dynamic approaches can offer solutions for re-planning problems, in the longer term. (Gomes and Ramos, 2019) needs to deal with changes in the pool of patients (departure and new arrivals) along with unusual continuity and non-loyalty constraints.

7.4. Modeling

Depending on what strategy is chosen to cope with uncertainty, the variability can be reflected either in the expression of the variables or in the model and the solving methods.

In stochastic approaches, random variables are used in 75% of the cases to express uncertainty, whereas a discrete set of scenarios is preferred in other cases, such as in (Naji et al., 2017) and (Rodriguez et al., 2015). In robust or flexible cases, variables may belong to a specific interval: in (Mosquera et al., 2018), visit times are modeled as decision variables with a preferred duration (upper bound) and a minimum duration (lower bound), the aim being to be as close as possible to the upper bound, allowing smaller times if necessary. On the contrary, in (Carello and Lanzarone, 2014) and (Carello et al., 2017), visit times are characterized by their expected value (lower

bound) and maximum value (upper bound), the aim being to be as close as possible to the lower bound, allowing higher times if necessary.

A traditional method in robust optimization consists in using a cardinality-constrained model. It enables the decision-maker to decide what level of conservatism he/she wants in the solution. For example, in (Cappanera et al., 2017), the conservatism degree bounds the number of uncertain demands per tour; in (Carello and Lanzarone, 2014) and (Carello et al., 2017), control is kept over the number of clients whose visit time does not meet the expected value; in (Nguyen and Montemanni, 2016), the number of missing nurses is limited. In cardinality-constrained models, the solutions are guaranteed to be feasible as long as these limitations are observed.

Stochastic programming seems to be appreciated by the authors: 32% of selected papers use stochastic models. The latest papers (not included in the tables) tend to confirm this trend (Zhan et al., 2020; Shi et al., 2019; Hashemi Doulabi et al., 2020).

In dynamic cases, the initial schedule is built from a deterministic method and is then altered to remain feasible in spite of contingencies. As a consequence, the differences occur in the solving methods: we can find an insertion heuristic (Bennett and Erera, 2011), multi-agent simulation with recourse action (Marcon et al., 2017), a repair method (Xie and Wang, 2017) or a scenario-based approach (Demirbilek et al., 2019).

7.5. Objectives

The objective functions often reflect the different motivations behind the consideration of uncertainties. In 67% of the papers, the objective function does not change from the one used in the deterministic problem. Travel, working and idle times are minimized, workloads are balanced, general costs are minimized, etc. It should be noted that these objective functions are mostly considered when the uncertainty is handled with stochastic or robust models. In (Carello et al., 2017) and (Naji et al., 2017), the objective function is minimized in the worst-case scenario.

In the remaining 33% of papers, the objective function directly depends on the changes

induced by the contingencies.

A frequent objective is also to minimize the deviation from the original schedule. The calculation of such a deviation differs according to the papers: Nickel et al. (2012) consider the changes in the starting times of the cares, while Shi et al. (2017b) compute extra-working times and delayed visits. In (Yuan and Jiang, 2017), three criteria are jointly minimized: (1) changes in starting times of care, (2) changes in the length of the tour, and the succession of patients, (3) additional costs due to late penalties, overtime costs, etc. Costs induced by the changes in the initial planning are taken into account in 19% of papers: it includes delayed visit penalties or reassignment costs.

Du et al. (2017b) consider a different problem with patients requiring a visit in an emergency. Their goal is to minimize the response time, i.e. to provide the visit as soon as possible after the request is sent by the patient in need.

7.6. Discussion on uncertainties and dynamic aspects

The interest in dynamic aspects and uncertainties is extremely recent: the first paper of our selection dates back to 2011. Therefore we lack some hindsight to analyze the evolution of the studied criteria throughout the years. However, it is to be noted that flexibility has not been given much attention, unlike stochastic or dynamic problems. Furthermore, whether it is in the objectives or the contingencies, staff members are clearly not the main focus of the authors: they prefer considering patient preference, or economic aspects. Even though the preferences of the staff members do not appear to be a priority, the HHC field has a high turnover of staff because of the extremely hard working conditions. Granting more importance to the workers' well-being would probably reduce the number of contingencies and would bring more stability to HHC agencies.

8. Discussion and Future research directions

Due to its crucial contribution to society, the problem of routing and scheduling in the HHC context has received increasing attention in recent years. Figure 11 indicates

the proportion of papers considering the main features we identified. The darker the feature is represented, the more it is studied in our selection of papers. As shown in Figure 11, this problem covers a variety of applicative research involving HHC agencies. Authors often use real-life instances to validate their methods. Objective functions and constraints are numerous. The results of this literature survey also show the large variety of problems addressed when considering planning in HHC agencies. Most of these are extensions of the VRP, with classically considered objectives (such as travel costs) or constraints (such as time windows, legislative rules, skills, etc.). This survey also shows some recent uncommon constraints (like dependency constraints, continuity of care, etc.), which are very close to real-life cases.

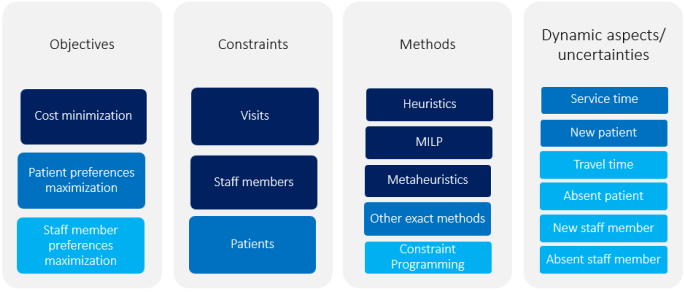

Figure 11: Illustration of the main characteristics of the analyzed papers

In the most recent papers, we observed the emergence of several trends. Some research avenues were already identified in the latest literature reviews (Cissé et al., 2017) and (Grieco et al., 2020). As we will show below, some of the main trends observed recently go in the direction of the already identified avenues, others in these avenues are still relevant, and furthermore, new ones appear.

We structure the main trends and research questions according to five areas: approaches and benchmarks, specific constraints, uncertainties, sustainability and means of transportation, and finally, multi-objective methods to consider all stakeholders.

8.1. Approaches and benchmarks

As far as methods are concerned, we observe an evolution: whereas the first studies traditionally proposed methods based either on mathematical programming, in particu-

lar, the MILP, or on dedicated heuristics, efficient methods for the other VRP extensions have since been developed. Thus, several authors propose advanced optimization methods based on Lagrangian relaxation, such as (Fathollahi-Fard et al., 2019), or Benders decomposition, such as (Heching et al., 2019). Metaheuristics, like in (Fathollahi-Fard et al., 2020),or in (Inanç and Şenaras, 2020) and memetic approaches, such as (Decerle et al., 2019b) are also booming. These new methods make it possible to deal with larger instances and longer planning horizons. We also note the appearance of more emerging approaches, such as multi-agent (Hamdani et al., 2019) or AI methods to take into account or better model certain uncertainties inherent in the field of home care and service. This trend is all set to continue in the coming years. Indeed, this evolution of methods follows a classical pattern in the development of operational research methods for a given type of problem. For methods that allow better consideration of available data and/or that allow the development of dynamic approaches, this corresponds to a much more general current trend and, once again, this trend is all set to continue.

Furthermore, each author usually develops their specific method for their problem and tests it on their data. It could be interesting to work on more generic models, as already suggested in (Cissé et al., 2017), but also to provide some new benchmarks, containing all the characteristics of interest of an HHC scheduling and routing problem in HHC agencies.

Finally, the need identified in (Grieco et al., 2020) to consider routing and scheduling in the HHC sector as a whole (including contextual and environmental factors) and in all its dimensions (strategic, tactical, and operational) remains a topical issue.

8.2. Specifics constraints

The constraints considered are numerous. Nevertheless, some of them have been paid more attention. Some are already subject to VRP extensions, while others are specific to the HHCRSP. We will focus here on these and, more especially, on continuity of care, preferences, and synchronization and dependency constraints.

Continuity of care: we noted that patient constraints, particularly those related to continuity of care, were not often considered, although they have an impact on improving the quality of service of HHC agencies. There are two types of continuity of care:

human continuity and temporal continuity. We can define 'Temporal continuity' by visiting the patient at the same hour each time. Only a few recent papers consider this type of continuity despite the fact that it directly affects patient satisfaction. We can define 'Human continuity' by assigning the same staff member (or the same pool of staff members) to a given patient throughout the period. Usually, even in the most recent papers, such as (Demirbilek et al., 2019) or (Entezari and Mahootchi, 2020), only the first aspect is considered. Continuity of care is a reality and a concern for HCC agencies. Considering a pool of staff members is the only way to consider continuity of care and day-off simultaneously. Therefore, this point is crucial in the quality of service, and increasingly more studies should make this point central key one.

Patient and Staff Member preferences: We observed that even if cost criteria are the most studied criteria, there is an increasing interest in maximization of patient and staff member preferences, as in (Zhu et al., 2019) or (Liu et al., 2019c), for instance. We think that it is significant to take these aspects further, for the HHC agencies to remain competitive by providing a good quality of service for their patients, and a conducive working environment for their staff members. Moreover, this will facilitate the acceptance of the proposed methods and tools.

Synchronization and dependency constraints: A major trend in the most recent papers is the consideration of dependency constraints as in (Frifita and Masmoudi, 2020), (Liu et al., 2019c), Nozir et al. (2020), or Euchi et al. (2020), for example. Indeed, the HHC sector has a specificity in the VRP field. Some patients require, in the context of their care, the simultaneous or successive presence of several staff members. Synchronization of tours combined with flexible or hard time windows linked to the care, to the patient, or to the staff members is a challenging and promising avenue. Recent papers focus on the need for some services to have two staff members present at the same time with the patient. Other types of temporal dependencies exist in the HHC environment, including precedence or even strict precedence. Indeed, some care requires the intervention of a staff member with specific skills, followed almost immediately by another staff member with other skills. Taking these kinds of constraints into account is challenging. In (Cissé et al., 2017), the need, to carry out studies taking the different types of time windows into account, has already been highlighted. This avenue is still

relevant. Recent studies have clearly shown that besides the different types of time windows, the different types of dependencies and synchronization are key constraints.

8.3. Uncertainties

One of the main promising avenues of research is the consideration of uncertainties since these uncertainties are inherent to the HHC sector. In real life, several uncertainties can affect the solutions, as seen in section 7. Concerning these uncertainties, most papers focus mainly on classical uncertainties about duration of services and travel times. Most papers propose a stochastic approach to these uncertainties (Nikzad et al., 2020), (Shi et al., 2019) and more recently a few papers propose a dynamic approach (Ouertani et al., 2019) to address this type of uncertainties. In this sense, these studies are initial answers to the avenues of research identified by Cissé et al. (2017). However, the HHC sector presents specific uncertainties. Thus, as in all medical sectors, home care facilities and services must deal with emergencies: a patient not foreseen in the tour to visit or a staff member absent at the last minute when it is not possible to cancel his/her visits. These unexpected inflows/outflows of patients and staff members are present daily in the HHC structures and require the development of dynamic approaches as already pointed out in (Cissé et al., 2017), as well as robust planning methods. Patients of HHC agencies are fragile people who need stability and no unexpected events, so robust approaches to uncertainties or at least flexible models continue to be essential to improve the quality of service provided by HHC agencies.

8.4. Sustainability and means of transportation

Some recent papers consider sustainability aspects. Two main ways are proposed: minimization of gas emissions, or environmentally friendly means of transportation. Hence, some recent studies consider the minimization of environmental pollution such as (Fathollahi-Fard et al., 2018a). Others consider the combination of means of transportation, such as public transportation, combined with walking, such as (Rest and Hirsch, 2016) or the combination of walking and car/trip sharing for staff members, such as (Fikar and Hirsch, 2015), or the use of electric cars or bicycles such as (Szander et al., 2019), or (Erdem and Koç, 2019). Sustainability is a crucial societal problem,

and we believe that it is relevant to develop new approaches considering this aspect in future research, especially from the perspective of mobility, as has already begun in some studies like (Voegl and Hirsch, 2019).

Consideration of different means of transportation used by staff members is rarely addressed in the literature, where most works focus on the private transportation mode, i.e. cars. In this, the research trail proposed in (Cissé et al., 2017) continues to apply. Some authors have considered public transportation modes, or some combinations of car, public transport, and walking. Combining transportation modes could significantly improve services and reduce costs. Furthermore, especially in urban areas, innovative modes of transportation are emerging, and new kinds of mobility are booming: car, bicycle or scooter sharing, as well as carpooling, are some examples.

Mobility of staff members will evolve, and proposing planning methods able to take these new modes of mobility into account is a very promising avenue. Since each of these transportation modes has its own specific constraints and restrictions, a key avenue is to propose realistic schedules.

8.5. Multi-objective approaches to consider all the stakeholders

Most papers consider multiple criteria, but usually with a single objective function, often a weighted sum. However, assigning some weights may be difficult and not satisfying for decision makers. Moreover, it could be more interesting to obtain a set of alternative solutions rather than only one solution, representing some tradeoff between the different criteria of interest, and to develop methods helping to choose the most suitable solution out of those provided. For this reason, a few papers recently developed some multi-objective resolution methods. We think that to propose new multi-objective resolution methods for the scheduling and routing problem in HHC agencies is an interesting avenue. In (Cissé et al., 2017), this point was already highlighted, and it is still current.

Over and beyond the multi-objective method aspect, other aspects related to multi-objective are real avenues of ambitious research. The home care and service sector is no exception to the rule of the presence of several stakeholders with conflicting interests. Many papers focus on the financial aspects by minimizing a classic criterion

for VRP distance traveled, a topical economic objective for HHC agencies. Patients also receive special attention, with several papers focusing on patient satisfaction and quality of service. However, the third stakeholder, the staff members, are still too often forgotten, even if some studies are beginning to propose objective functions that are staff member-centered such as (Zhang et al., 2019), (Khodabandeh et al., 2020). Indeed, few studies focus on staff member satisfaction, although they play a topical role in the quality of service and patient satisfaction and thus on the economic sustainability of the HHC agency. As the HHC sector suffers from the large turnover of its staff members, proposing methods aiming at staff members' satisfaction is an important avenue. Developing studies that find tradeoffs and reconcile the interests of the different stakeholders is a crucial challenge.

9. Conclusions

In this paper, we propose a literature survey on the routing and scheduling problem in the HHC context, a field that has received increasing attention in the recent years. The main contributions of our literature survey are as follows:

- We provide a synthesis of the literature dealing with routing and scheduling in the HHC context, through a numerical analysis and a classification of the papers, emphasizing the large variety of problems studied and solutions proposed, objective functions considered (cost and preference for patients or staff members), constraints considered (related to visits, patients, or staff members), and highlighting the uncertain and dynamic aspects.

- We provide some discussions on current trends in HHC routing and scheduling, showing several new recent characteristics, such as multi-modality or sustainability.

- We propose future research directions to solve realistic problems and help HHC agencies provide increasingly better services for their patients, ensuring a good working environment for their staff members, while being sustainable.

References

Aiane, D., El-Amraoui, A., Mesghouni, K., 2015. A new optimization approach for a home health care problem. International Conference on Industrial Engineering and Systems Management (IESM), Sevilla, Spain , 285–290.

Ait Haddadene, S., Labadie, N., Prodhon, C., 2016a. A GRASP $\textbackslashtimes$ ILS for the vehicle routing problem with time windows, synchronization and precedence constraints. Expert Systems with Applications 66, 274 – 294.

Ait Haddadene, S., Labadie, N., Prodhon, C., 2016b. NSGAII enhanced with a local search for the vehicle routing problem with time windows and synchronization constraints. IFAC Conference on Manufacturing Modelling, Management and Control (MIM), Troyes, France 49, 1198 – 1203.

Akjiratikarl, C., Yenradee, P., Drake, P., 2007. PSO-based algorithm for home care worker scheduling in the UK. Computers & Industrial Engineering 53, 559–583.

Allaoua, H., Borne, S., Létocart, L., Calvo, R., 2013. A matheuristic approach for solving a home health care problem. Electronic Notes in Discrete Mathematics 41, 471–478.

Alves, F., Alvelos, F., Rocha, A., Pereira, A., Leitão, P., 2019a. Periodic vehicle routing problem in a health unit, pp. 384–389.

Alves, F., Costa, L., Rocha, A., Pereira, A., Leitão, P., 2019b. A multi-objective approach to the optimization of home care visits scheduling, pp. 435–442.

Alves, F., Pereira, A., Barbosa, J., Leitão, P., 2018a. Scheduling of home health care services based on multi-agent systems. Communications in Computer and Information Science 887, 12–23. doi:10.1007/978-3-319-94779-2_2.

Alves, F., Pereira, A., Fernandes, F., Fernandes, A., Leitão, P., Martins, A., 2017. Optimal schedule of home care visits for a health care center. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and

Lecture Notes in Bioinformatics) 10406 LNCS, 135–147. doi:10.1007/978-3-319-62398-6_10.

Alves, F., Pereira, A.I., Fernandes, A., Leitão, P., 2018b. Optimization of Home Care Visits Schedule by Genetic Algorithm, in: Korošec, P., Melab, N., Talbi, E.G. (Eds.), Bioinspired Optimization Methods and Their Applications, Springer International Publishing. pp. 1–12.

An, Y.J., Kim, Y., Jeong, B., Kim, S.D., 2012. Scheduling healthcare services in a home healthcare system. Journal of the Operational Research Society 63.

Bard, J., Shao, Y., Jarrah, A., 2014a. A sequential GRASP for the therapist routing and scheduling problem. Journal of Scheduling 17, 109–133.

Bard, J., Shao, Y., Qi, X., Jarrah, A., 2014b. The traveling therapist scheduling problem. IIE Transactions 46, 683–706.

Bard, J., Shao, Y., Wang, H., 2013. Weekly scheduling models for traveling therapists. Socio-Economic Planning Sciences 47, 191–204.

Bashir, B., Chabrol, M., Caux, C., 2012. Literature review in home care. 9th International Conference on Modelling and Simulation (MOSIM), Bordeaux, France .

Baumann, P., 2017. Optimal staff assignment and routing in personalized home care, in: 2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), pp. 1027–1031. doi:10.1109/IEEM.2017.8290048.

Becker, C., Lorig, F., Timm, I., 2019. Multiagent systems to support planning and scheduling in home health care management: A literature review. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) 11326 LNAI, 13–28. doi:10.1007/978-3-030-12738-1_2.

Begur, S., Miller, D., Weaver, J., 1997. An integrated spatial DSS for scheduling and routing home-health-care nurses. Interfaces 27, 35–48. doi:10.1287/inte.27.4.35.

Ben Bachouch, R., Guinet, A., Hajri-Gabouj, S., 2011. A Decision-Making Tool for Home Health Care Nurses' Planning. Supply Chain Forum: an International Journal 12, 14–20.

Bennett, A., Erera, A., 2011. Dynamic periodic fixed appointment scheduling for home health. IIE Transactions on Healthcare Systems Engineering 1, 6–19.

Benzarti, E., Sahin, E., Dallery, Y., 2013. Operations management applied to home care services: Analysis of the districting problem. Decision Support Systems 55, 587–598.

Bertels, S., Fahle, T., 2006. A hybrid setup for a hybrid scenario: combining heuristics for the home health care problem. Computers & Operations Research 33, 2866–2890.

Borsani, V., Matta, A., Beschi, G., Sommaruga, F., 2006. A home care scheduling model for human resources. International Conference on Service Systems and Service Management (ICSSSM), Troyes, France 1, 449–454.

Bowers, J., Cheyne, H., Mould, G., Page, M., 2015. Continuity of care in community midwifery. Health Care Management Science 18, 195–204.

Braekers, K., Hartl, R., Parragh, S., Tricoire, F., 2016. A bi-objective home care scheduling problem: Analyzing the trade-off between costs and client inconvenience. European Journal of Operational Research 248, 428–443.

Bredström, D., Rönnqvist, M., 2008. Combined vehicle routing and scheduling with temporal precedence and synchronization constraints. European Journal of Operational Research 191, 19–31.

Cappanera, P., Scutellà, M.G., 2013. Home Care optimization: impact of pattern generation policies on scheduling and routing decisions. Electronic Notes in Discrete Mathematics 41, 53 – 60.

Cappanera, P., Scutellà, M.G., 2014. Joint assignment, scheduling, and routing models to home care optimization: A pattern-based approach. Transportation Science 49, 830–852.

Cappanera, P., Scutellà, M.G., Nervi, F., Galli, L., 2017. Demand uncertainty in robust Home Care optimization. Omega-International Journal of Management Science URL: http://www.sciencedirect.com/science/article/pii/S0305048316309008, doi:10.1016/j.omega.2017.08.012.

Cappanera, P., Scutellà, M.G., Visintin, F., 2014. Home Care Services Delivery: Equity Versus Efficiency in Optimization Models, in: Matta, A., Li, J., Sahin, E., Lanzarone, E., Fowler, J. (Eds.), Proceedings of the International Conference on Health Care Systems Engineering, Springer International Publishing. pp. 1–13.

Carello, G., Lanzarone, E., 2014. A cardinality-constrained robust model for the assignment problem in home care services. European Journal of Operational Research 236, 748–762.

Carello, G., Lanzarone, E., Laricini, D., Servilio, M., 2017. Handling Time-Related Demands in the Home Care Nurse-to-Patient Assignment Problem with the Implementor-Adversarial Approach, in: Health Care Systems Engineering, Springer, Cham. pp. 87–97. URL: https://link-springer-com.gaelnomade-2.grenet.fr/chapter/10.1007/978-3-319-66146-9_8, doi:10.1007/978-3-319-66146-9_8.

Carello, G., Lanzarone, E., Mattia, S., 2018. Trade-off between stakeholders' goals in the home care nurse-to-patient assignment problem. Operations Research for Health Care 16, 29–40. URL: http://www.sciencedirect.com/science/article/pii/S2211692316300716, doi:10.1016/j.orhc.2017.12.002.

Cattafi, M., Herrero, R., Gavanelli, M., Nonato, M., Malucelli, F., 2012. Improving quality and efficiency in home health care: An application of constraint logic programming for the Ferrara NHS unit. Technical Communications of the 28th International Conference on Logic Programming (ICLP'12), Budapest, Hungary 17, 415–424.

Cattafi, M., Herrero, R., Gavanelli, M., Nonato, M., Malucelli, F., 2015. An application of constraint solving for home health care. AI Communications 28, 215–237.

Chahed, S., Marcon, E., Sahin, E., Feillet, D., Dallery, Y., 2009. Exploring new operational research opportunities within the home care context: the chemotherapy at home. Health Care Management Science 12, 179–191.

Chaieb, M., Jemai, J., Mellouli, K., 2019. A decomposition - construction approach for solving the home health care scheduling problem. Health care management science doi:10.1007/s10729-019-09479-z.

Chen, C., Rubinstein, Z., Smith, S., Lau, H.C., 2017. Tackling large-scale home health care delivery problem with uncertainty. Proceedings of the Twenty-Seventh International Conference on Automated Planning and Scheduling ICAPS 2017: Pittsburgh, June 18-23 , 358–366URL: http://ink.library.smu.edu.sg/sis_research/3864.

Cinar, A., Salman, F.S., Bozkaya, B., 2019. Prioritized single nurse routing and scheduling for home healthcare services. European Journal of Operational Research URL: http://www.sciencedirect.com/science/article/pii/S0377221719305739, doi:10.1016/j.ejor.2019.07.009.

Cissé, M., Yalçındağ, S., Kergosien, Y., Şahin, E., Lenté, C., Matta, A., 2017. OR problems related to Home Health Care: A review of relevant routing and scheduling problems. Operations Research for Health Care 13-14, 1–22. URL: http://www.sciencedirect.com/science/article/pii/S2211692316300157, doi:10.1016/j.orhc.2017.06.001.

Cordeau, J.F., Desaulniers, G., Desrosiers, J., Solomon, M.M., Soumis, F., 2000. The VRP with time windows. Les cahiers du GERAD G-99-13.

Dantzig, G.B., Ramser, J.H., 1959. The Truck Dispatching Problem. Management Science 6, 80–91. URL: https://pubsonline.informs.org/doi/abs/10.1287/mnsc.6.1.80, doi:10.1287/mnsc.6.1.80. publisher: INFORMS.

De Angelis, V., 1998. Planning home assistance for aids patients in the city of rome, italy. Interfaces 28, 75–83.

Decerle, J., Grunder, O., El Hassani, A., Barakat, O., 2016. A two-phases matheuristic for the home care routing and scheduling problem. IFAC Conference on Manufacturing Modelling, Management and Control (MIM), Troyes, France 49, 1484–1489.

Decerle, J., Grunder, O., El Hassani, A.H., Barakat, O., 2018a. A matheuristic for a multi-depot home health care problem. IFAC-PapersOnLine 51, 340–345. URL: http://www.sciencedirect.com/science/article/pii/S2405896318314307, doi:10.1016/j.ifacol.2018.08.306.

Decerle, J., Grunder, O., Hajjam El Hassani, A., Barakat, O., 2018b. A memetic algorithm for a home health care routing and scheduling problem. Operations Research for Health Care 16, 59–71. URL: http://www.sciencedirect.com/science/article/pii/S2211692317300735, doi:10.1016/j.orhc.2018.01.004.

Decerle, J., Grunder, O., Hajjam El Hassani, A., Barakat, O., 2019a. A hybrid memetic-ant colony optimization algorithm for the home health care problem with time window, synchronization and working time balancing. Swarm and Evolutionary Computation 46, 171–183. doi:10.1016/j.swevo.2019.02.009.

Decerle, J., Grunder, O., Hajjam El Hassani, A., Barakat, O., 2019b. A memetic algorithm for multi-objective optimization of the home health care problem. Swarm and Evolutionary Computation 44, 712–727. doi:10.1016/j.swevo.2018.08.014.

Decerle, J., Grunder, O., Hassani, A.H.E., Barakat, O., 2017. Impact analysis of workload balancing on the home health care routing and scheduling problem, in: 2017 4th International Conference on Control, Decision and Information Technologies (CoDIT), pp. 0096–0101. doi:10.1109/CoDIT.2017.8102573.

Decerle, J., Grunder, O., Hassani, A.H.E., Barakat, O., 2018c. Impact of the workload definition on the multi-objective home health care problem, in: IFAC-PapersOnLine, pp. 346–351. URL: http://www.sciencedirect.com/science/article/pii/S2405896318314320, doi:10.1016/j.ifacol.2018.08.308.

Dekhici, L., Redjem, R., Belkadi, K., Mhamedi, A., 2019. Discretization of the Firefly

Algorithm for Home Care. Canadian Journal of Electrical and Computer Engineering 42, 20–26. doi:10.1109/CJECE.2018.2883030.

Demirbilek, M., Branke, J., Strauss, A., 2018. Dynamically accepting and scheduling patients for home healthcare. Health Care Management Science , 1–16URL: https://link-springer-com.gaelnomade-2.grenet.fr/article/10.1007/s10729-017-9428-0, doi:10.1007/s10729-017-9428-0.

Demirbilek, M., Branke, J., Strauss, A., 2019. Home healthcare routing and scheduling of multiple nurses in a dynamic environment. Flexible Services and Manufacturing Journal doi:10.1007/s10696-019-09350-x.

Detolle, J., 2001. Le référentiel afnor «services aux personnes à domicile». Gérontologie et société 24, 241–254.

Di Gaspero, L., Urli, T., 2014. A CP/LNS approach for multi-day homecare scheduling problems. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) 8457, 1–15.

Di Mascolo, M., Espinouse, M.L., El Hajri, Z., 2017a. Planning in Home Health Care Structures: A literature review. IFAC-PapersOnLine 50, 4654–4659. doi:10.1016/j.ifacol.2017.08.689.

Di Mascolo, M., Espinouse, M.L., Gruau, P., Radureau, J., 2017b. A decision-making tool for the calculation of a robust planning for home service employees, pp. 167–177. doi:10.1007/978-3-319-66146-9_15.

Di Mascolo, M., Espinouse, M.L., Haddadene, S., 2018. Taking patients' wishes into account for daily planning in the Home Health Care contex, in: IFAC-PapersOnLine, pp. 1010–1015. doi:10.1016/j.ifacol.2018.08.475.

Di Mascolo, M., Espinouse, M.L., Ozkan, C.E., 2014. Synchronization between human resources in Home Health Care context. Proceedings of the first International Conference on Health Care Systems Engineering, Milan, Italy , 73–86.

Du, G., Liang, X., Sun, C., 2017a. Scheduling Optimization of Home Health Care Service Considering Patients' Priorities and Time Windows. Sustainability 9, 1–22. URL: http://www.mdpi.com/2071-1050/9/2/253, doi:10.3390/su9020253.

Du, G., Zheng, L., Ouyang, X., 2017b. Real-time scheduling optimization considering the unexpected events in home health care. Journal of Combinatorial Optimization 37, 196–220. doi:10.1007/s10878-017-0220-3.

El Hajri, Z., Di Mascolo, M., Espinouse, M.L., Radureau, J., 2017. A Multi-objective Model for Home Service Assignment and Routing Problem, in: 20th World Congress of the International Federation of Automatic Control, IFAC 2017, Juillet 2017, Toulouse, France, Toulouse, France. URL: https://hal.archives-ouvertes.fr/hal-01576247.

Elbenani, B., Ferland, J., Gascon, V., 2008. Mathematical programming approach for routing home care nurses. IEEE International Conference on Industrial Engineering and Engineering Management, Singapore , 107–111.

Eliseu, M., Gomes, M., Juan, A., 2018. A biased-randomized heuristic for the home healthcare routing problem, pp. 57–67. doi:10.1007/978-3-319-71583-4_5.

Emiliano, W., Telhada, J., Carvalho, M.d.S., 2017. Home health care logistics planning: a review and framework. Procedia Manufacturing 13, 948–955. URL: http://www.sciencedirect.com/science/article/pii/S2351978917308028, doi:10.1016/j.promfg.2017.09.165.

En-nahli, L., Afifi, S., Allaoui, H., Nouaouri, I., 2016. Local Search Analysis for a Vehicle Routing Problem with Synchronization and Time Windows Constraints in Home Health Care Services. IFAC Conference on Manufacturing Modelling, Management and Control (MIM), Troyes, France 49, 1210–1215.

En-nahli, L., Allaoui, H., Nouaouri, I., 2015. A Multi-objective Modelling to Human Resource Assignment and Routing Problem for Home Health Care Services. IFAC 48, 698 – 703.

Entezari, Z., Mahootchi, M., 2020. Developing a mathematical model for staff routing and scheduling in home health care industries: Genetic Algorithm based solution scheme. Scientia Iranica 0. URL: http://scientiairanica.sharif.edu/article_21775.html, doi:10.24200/sci.2020.54116.3600. publisher: Sharif University of Technology.

Erdem, M., Bulkan, S., 2017. A two-stage solution approach for the large-scale home healthcare routeing and scheduling problem. South African Journal of Industrial Engineering 28, 133–149. doi:10.7166/28-4-1754.

Erdem, M., Koç, C., 2019. Analysis of electric vehicles in home health care routing problem. Journal of Cleaner Production 234, 1471–1483. URL: http://www.sciencedirect.com/science/article/pii/S0959652619322012, doi:10.1016/j.jclepro.2019.06.236.

Errarhout, A., Kharraja, S., Zorkani, I., 2013. Caregivers' assignment problem in home health care structures, in: Proceedings of 2013 International Conference on Industrial Engineering and Systems Management (IESM), Rabat, Morocco. pp. 1–8.

Espadinha, D., Cardoso-Grilo, T., 2019. Planning the Delivery of Home-Based Long-Term Care: A Mathematical Programming-Based Tool to Support Routes' Planning, pp. 107–124. doi:10.1007/978-3-030-10731-4_8.

Espinouse, M.L., Di Mascolo, M., Thiard, F., 2014. Exact method of daily planning with consideration of temporal constraints to optimize the patient's satisfaction in the Home Health Care context. CIE44 & IMSS'14 Proceedings, Istanbul, Turkey .

Euchi, J., 2020. Optimising the routing of home health caregivers: can a hybrid ant colony metaheuristic provide a solution? British Journal of Healthcare Management 26, 192–196. doi:10.12968/bjhc.2019.0096. publisher: Mark Allen Group.

Euchi, J., Zidi, S., Laouamer, L., 2020. A Hybrid Approach to Solve the Vehicle Routing Problem with Time Windows and Synchronized Visits In-Home Health Care. Arabian Journal for Science and Engineering doi:10.1007/s13369-020-04828-5.

Eveborn, P., Flisberg, P., Rönnqvist, M., 2006. Laps Care—an operational system for staff planning of home care. European Journal of Operational Research 171, 962–976.

Fathollahi-Fard, A., Hajiaghaei-Keshteli, M., Mirjalili, S., 2019. A set of efficient heuristics for a home healthcare problem. Neural Computing and Applications doi:10.1007/s00521-019-04126-8.

Fathollahi-Fard, A.M., Ahmadi, A., Goodarzian, F., Cheikhrouhou, N., 2020. A bi-objective home healthcare routing and scheduling problem considering patients' satisfaction in a fuzzy environment. Applied Soft Computing 93, 106385. URL: http://www.sciencedirect.com/science/article/pii/S1568494620303252, doi:10.1016/j.asoc.2020.106385.

Fathollahi-Fard, A.M., Hajiaghaei-Keshteli, M., Tavakkoli-Moghaddam, R., 2018a. A bi-objective green home health care routing problem. Journal of Cleaner Production 200, 423–443. URL: http://www.sciencedirect.com/science/article/pii/S0959652618322479, doi:10.1016/j.jclepro.2018.07.258.

Fathollahi-Fard, A.M., Hajiaghaei-Keshteli, M., Tavakkoli-Moghaddam, R., 2018b. A Lagrangian Relaxation-based Algorithm to Solve a Home Health Care Routing Problem. International Journal of Engineering 31, 1734–1740. doi:10.5829/ije.2018.31.10a.16.

Feng, Q., Wang, J., 2018. Vehicle Routing Problem with Time Windows in Aged Service: A Delivery Service Model for the Elderly. doi:10.1109/ICSSSM.2018.8465115.

Fikar, C., Hirsch, P., 2015. A matheuristic for routing real-world home service transport systems facilitating walking. Journal of Cleaner Production 105, 300–310.

Fikar, C., Hirsch, P., 2017. Home health care routing and scheduling: A review. Computers & Operations Research 77, 86–95.

Fikar, C., Hirsch, P., 2018. Evaluation of trip and car sharing concepts for home health care services. Flexible Services and Manufacturing Journal 30, 78–97.

URL: https://doi.org/10.1007/s10696-016-9252-8, doi:10.1007/s10696-016-9252-8.

Fikar, C., Juan, A., Martinez, E., Hirsch, P., 2016. A discrete-event driven metaheuristic for dynamic home service routing with synchronised trip sharing. European Journal of Industrial Engineering 10, 323–340.

FNEHAD, 2020. Fédération Nationale des établissements d'Hospitalisation à Domicile. URL: https://www.fnehad.fr/.

Frifita, S., Masmoudi, M., 2020. VNS methods for home care routing and scheduling problem with temporal dependencies, and multiple structures and specialties. International Transactions in Operational Research 27, 291–313. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/itor.12604, doi:10.1111/itor.12604. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/itor.12604.

Frifita, S., Masmoudi, M., Euchi, J., 2017. General variable neighborhood search for home healthcare routing and scheduling problem with time windows and synchronized visits. Electronic Notes in Discrete Mathematics 58, 63–70. doi:10.1016/j.endm.2017.03.009.

Gamst, M., Jensen, T.S., 2012. A branch-and-price algorithm for the long-term home care scheduling problem, in: Operations Research Proceedings 2011, pp. 483–488.

Garaix, T., Gondran, M., Lacomme, P., Mura, E., Tchernev, N., 2018. Workforce Scheduling Linear Programming Formulation, in: IFAC-PapersOnLine, pp. 264–269. URL: http://www.sciencedirect.com/science/article/pii/S2405896318314137, doi:10.1016/j.ifacol.2018.08.289.

Gayraud, F., Deroussi, L., Grangeon, N., Norre, S., 2013. A new mathematical formulation for the home health care problem. Procedia Technology 9, 1041–1047.

Gehring, H., Homberger, J., 1999. A Parallel Hybrid Evolutionary Metaheuristic for the Vehicle Routing Problem with Time Windows , 8.

Gehring, H., Homberger, J., 2002. Parallelization of a Two-Phase Metaheuristic for Routing Problems with Time Windows. Journal of Heuristics 8, 251–276. URL: https://doi.org/10.1023/A:1015053600842, doi:10.1023/A:1015053600842.

Gomes, M.I., Ramos, T.R.P., 2019. Modelling and (re-)planning periodic home social care services with loyalty and non-loyalty features. European Journal of Operational Research 277, 284–299. URL: http://www.sciencedirect.com/science/article/pii/S0377221719300967, doi:10.1016/j.ejor.2019.01.061.

Grenouilleau, F., Legrain, A., Lahrichi, N., Rousseau, L.M., 2019. A set partitioning heuristic for the home health care routing and scheduling problem. European Journal of Operational Research 275, 295–303. URL: http://www.sciencedirect.com/science/article/pii/S0377221718309500, doi:10.1016/j.ejor.2018.11.025.

Grieco, L., Utley, M., Crowe, S., 2020. Operational research applied to decisions in home health care: A systematic literature review. Journal of the Operational Research Society , 1–32URL: https://orsociety.tandfonline.com/doi/full/10.1080/01605682.2020.1750311, doi:10.1080/01605682.2020.1750311. publisher: Taylor & Francis.

Guericke, D., Suhl, L., 2017. The home health care problem with working regulations. OR Spectrum 39, 977–1010. URL: https://link-springer-com.gaelnomade-2.grenet.fr/article/10.1007/s00291-017-0481-3, doi:10.1007/s00291-017-0481-3.

Gunawan, A., Lau, H.C., Lu, K., 2017. Home Health Care Delivery Problem , 12.

Gutiérrez, E., Vidal, C., 2012. Home Health Care Logistics Management Problems: Framework and Research Perspectives. 3rd International conference on Industrial Engineering and Operations Management (IEOM), Istanbul, Turkey , 1–9.

Gutiérrez, E., Vidal, C., 2013. Home health care logistics management problems: A

critical review of models and methods. Revista Facultad de Ingeniería Universidad de Antioquia , 160–175.

Hamdani, F.E., El Mhamedi, A., Monticolo, D., 2019. Agent-based Approach of Multi-Structures Homecare Planning Problem, in: 2019 International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA), pp. 1–6. doi:10.1109/LOGISTIQUA.2019.8907268. iSSN: 2166-7373.

Hashemi Doulabi, H., Pesant, G., Rousseau, L.M., 2020. Vehicle Routing Problems with Synchronized Visits and Stochastic Travel and Service Times: Applications in Healthcare. Transportation Science 54, 1053–1072. doi:10.1287/trsc.2019.0956. publisher: INFORMS.

Heching, A., Hooker, J., 2016. Scheduling home hospice care with logic-based benders decomposition. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) 9676, 187–197.

Heching, A., Hooker, J.N., Kimura, R., 2019. A Logic-Based Benders Approach to Home Healthcare Delivery. Transportation Science 53, 510–522. URL: http://pubsonline.informs.org/doi/abs/10.1287/trsc.2018.0830, doi:10.1287/trsc.2018.0830.

Hiermann, G., Prandtstetter, M., Rendl, A., Puchinger, J., Raidl, G., 2015. Metaheuristics for solving a multimodal home-healthcare scheduling problem. Central European Journal of Operations Research 23, 89–113.

Hindle, T., Hindle, A., Spollen, M., 2000. Resource allocation modelling for home-based health and social care services in areas having differential population density levels: a case study in Northern Ireland. Health Services Management Research 13, 164–169.

Hindle, T., Hindle, G., Spollen, M., 2009. Travel-related costs of population dispersion in the provision of domiciliary care to the elderly: a case study in English Local Authorities. Health Services Management Research 22, 27–32.

Hirsch, P., 2018. Recent planning approaches and mobility concepts for home health care services in Austria – A review. Die Bodenkultur: Journal of Land Management, Food and Environment 68, 205–222. URL: https://content.sciendo.com/view/journals/boku/68/4/article-p205.xml, doi:10.1515/boku-2017-0017.

Inanç, S., Şenaras, A.E., 2020. An Application for Routing Ambulance via ACO in Home Healthcare. URL: www.igi-global.com/chapter/an-application-for-routing-ambulance-via-aco-in-home-healthcare/238486.

INSEE, 2020. National Institute of Statistics and Economic Studies - Tableaux de l'économie Française - Dépenses de Santé. URL: https://www.insee.fr/fr/statistiques/4277750?sommaire=4318291#consulter-sommaire.

Issaoui, B., Zidi, I., Marcon, E., Ghedira, K., 2015a. New multi-objective approach for the home care service problem based on scheduling algorithms and variable neighborhood descent. Electronic Notes in Discrete Mathematics 47, 181–188.

Issaoui, B., Zidi, I., Marcon, E., Laforest, F., Ghedira, K., 2015b. Literature review: Home health care. 15th International Conference on Intelligent Systems Design and Applications (ISDA), Marrakesh, Morocco , 485–492.

Jemai, J., C., M., Mellouli, K., 2013. The home care scheduling problem: A modeling and solving issue. 5th International Conference on Modeling, Simulation and Applied Optimization (ICMSAO), Hammamet, Tunisia , 1–6.

Kandakoglu, A., Sauré, A., Michalowski, W., Aquino, M., Graham, J., McCormick, B., 2020. A decision support system for home dialysis visit scheduling and nurse routing. Decision Support Systems 130, 113224. URL: http://www.sciencedirect.com/science/article/pii/S0167923619302532, doi:10.1016/j.dss.2019.113224.

Kergosien, Y., Lenté, C., Billaut, J.C., 2009. Home health care problem: An extended multiple traveling salesman problem. 4th Multidisciplinary International Conference on Scheduling: Theory and Applications (MISTA'09), Dublin, Irlande , 10–12.

Kergosien, Y., Ruiz, A., Soriano, P., 2014. A routing problem for medical test sample collection in home health care services. Proceedings of the International Conference on Health Care Systems Engineering (ICHCSE), Berlin, Germany , 29–46.

Khodabandeh, P., Kayvanfar, V., Rafiee, M., Werner, F., 2020. A Bi-Objective Home Health Care Routing and Scheduling Model with Considering Nurse Downgrading Costs URL: https://www.preprints.org/manuscript/202011.0310/v1, doi:10.20944/preprints202011.0310.v1. publisher: Preprints.

Koeleman, P., Bhulai, S., van Meersbergen, M., 2012. Optimal patient and personnel scheduling policies for care-at-home service facilities. European Journal of Operational Research 219, 557–563.

Labadie, N., Prins, C., Yang, Y., 2014. Iterated Local Search for a Vehicle Routing Problem with Synchronization Constraints. International Conference on Operations Research and Enterprise Systems (ICORES), Angers, France , 257–263.

Laesanklang, W., Landa-Silva, D., Castillo-Salazar, J., 2015. Mixed integer programming with decomposition to solve a workforce scheduling and routing problem .

Lahrichi, N., Lanzarone, E., Yalçındağ, S., 2017. A new decomposition approach for the home health care problem, pp. 27–36. doi:10.1007/978-3-319-66146-9_3.

Lanzarone, E., Matta, A., 2012. A cost assignment policy for home care patients. Flexible Services and Manufacturing Journal 24, 465–495.

Lanzarone, E., Matta, A., 2014. Robust nurse-to-patient assignment in home care services to minimize overtimes under continuity of care. Operations Research for Health Care 3, 48–58.

Lieder, A., Moeke, D., Koole, G., Stolletz, R., 2015. Task scheduling in long-term care facilities: A client-centered approach. Operations Research for Health Care 6, 11 – 17.

Lin, C.C., Hung, L.P., Liu, W.Y., Tsai, M.C., 2018. Jointly rostering, routing, and rerostering for home health care services: A harmony search approach with genetic,

saturation, inheritance, and immigrant schemes. Computers & Industrial Engineering 115, 151–166. URL: http://www.sciencedirect.com/science/article/pii/S0360835217305259, doi:10.1016/j.cie.2017.11.004.

Lin, M., Chin, K., Wang, X., Tsui, K., 2016. The therapist assignment problem in home healthcare structures. Expert Systems with Applications 62, 44 – 62.

Liu, M., Yang, D., Su, Q., Xu, L., 2018. Bi-objective approaches for home healthcare medical team planning and scheduling problem. Computational and Applied Mathematics 37, 4443–4474. URL: https://doi.org/10.1007/s40314-018-0584-8, doi:10.1007/s40314-018-0584-8.

Liu, R., Tao, Y., Xie, X., 2019a. An adaptive large neighborhood search heuristic for the vehicle routing problem with time windows and synchronized visits. Computers and Operations Research 101, 250–262. doi:10.1016/j.cor.2018.08.002.

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, 475–486.

Liu, R., Yuan, B., Jiang, Z., 2017. Mathematical model and exact algorithm for the home care worker scheduling and routing problem with lunch break requirements. International Journal of Production Research 55, 558–575.

Liu, R., Yuan, B., Jiang, Z., 2019b. A branch-and-price algorithm for the home-caregiver scheduling and routing problem with stochastic travel and service times. Flexible Services and Manufacturing Journal 31, 989–1011. URL: https://doi.org/10.1007/s10696-018-9328-8, doi:10.1007/s10696-018-9328-8.

Liu, W., Dridi, M., Hassani, A.H.E., Fei, H., 2019c. A Mathematical Model for Medium-Term Home Health Care Planning Problem, in: 2019 International Conference on Industrial Engineering and Systems Management (IESM), pp. 1–6. doi:10.1109/IESM45758.2019.8948184.

Luna, F., Cervantes, A., Isasi, P., 2013. Large-scale home care crew scheduling with a parallel evolutionary algorithm. 8th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing (3PGCIC), Compiegne, France , 588–593.

Luna, F., Cervantes, A., Isasi, P., Valenzuela-Valdés, J.F., 2017. Grid-enabled evolution strategies for large-scale home care crew scheduling. Cluster Computing , 1–13URL: https://link-springer-com.gaelnomade-2.grenet.fr/article/10.1007/s10586-017-1058-2, doi:10.1007/s10586-017-1058-2.

Manerba, D., Mansini, R., 2016. The nurse routing problem with workload constraints and incompatible services. IFAC Conference on Manufacturing Modelling, Management and Control (MIM), Troyes, France 49, 1192–1197.

Mankowska, D., Meisel, F., Bierwirth, C., 2014. The home health care routing and scheduling problem with interdependent services. Health Care Management Science 17, 15–30.

Marcon, E., Chaabane, S., Sallez, Y., Bonte, T., Trentesaux, D., 2017. A multi-agent system based on reactive decision rules for solving the caregiver routing problem in home health care. Simulation Modelling Practice and Theory 74, 134–151. doi:10.1016/j.simpat.2017.03.006.

Martin, E., Cervantes, A., Saez, Y., Isasi, P., 2020. IACS-HCSP: Improved ant colony optimization for large-scale home care scheduling problems. Expert Systems with Applications 142, 112994. doi:10.1016/j.eswa.2019.112994.

Martinez, C., Espinouse, M., Mascolo, M.D., 2018. Continuity of care in home services: a client-centered heuristic for the home health care routing and scheduling problem, in: 2018 5th International Conference on Control, Decision and Information Technologies (CoDIT), pp. 1045–1050. doi:10.1109/CoDIT.2018.8394968.

Masmoudi, M., Mellouli, R., 2014. MILP for synchronized-mTSPTW: Application to home healthcare scheduling. International Conference on Control, Decision and Information Technologies (CoDIT), Metz, France , 297–302.

Maya Duque, P., Castro, M., Sörensen, K., Goos, P., 2015. Home care service planning. The case of Landelijke Thuiszorg. European Journal of Operational Research 243, 292–301.

Milburn, A.B., 2012. Operations research applications in home healthcare, in: Handbook of Healthcare System Scheduling, pp. 281–302.

Mosquera, F., Smet, P., Vanden Berghe, G., 2018. Flexible home care scheduling. Omega-International Journal of Management Science 83, 80–95. doi:10.1016/j.omega.2018.02.005.

Moussavi, S., Mahdjoub, M., Grunder, O., 2019. A matheuristic approach to the integration of worker assignment and vehicle routing problems: Application to home healthcare scheduling. Expert Systems with Applications 125, 317–332. doi:10.1016/j.eswa.2019.02.009.

Mutingi, M., Mbohwa, C., 2013a. Home healthcare staff scheduling: A taxonomic state-of-the-Art review. International Conference on Industrial Engineering and Engineering Management (IEEM), Selangor, Malaysia , 1107–1111.

Mutingi, M., Mbohwa, C., 2013b. Home healthcare worker scheduling: A group genetic algorithm approach. Lecture Notes in Engineering and Computer Science 1, 721–725.

Mutingi, M., Mbohwa, C., 2014. Multi-objective homecare worker scheduling: A fuzzy simulated evolution algorithm approach. IIE Transactions on Healthcare Systems Engineering 4, 209–216.

Mısır, M., Smet, P., Berghe, G., 2015. An analysis of generalised heuristics for vehicle routing and personnel rostering problems. Journal of the Operational Research Society 66, 858–870.

Mısır, M., Verbeeck, K., De Causmaecker, P., Berghe, G., 2010. A Hyper-heuristic Approach to the Home Care Scheduling Problem. BFG09, Leuven, Belgium .

Naji, W., Masmoudi, M., Mellouli, R., 2017. A robust-MILP for synchronized-mTSPTW: Application to home health care under uncertainties, in: 2017 4th International Conference on Control, Decision and Information Technologies (CoDIT), pp. 1089–1094. doi:10.1109/CoDIT.2017.8102744.

Nasir, J.A., Dang, C., 2018. Solving a More Flexible Home Health Care Scheduling and Routing Problem with Joint Patient and Nursing Staff Selection. Sustainability 10, 0148. doi:10.3390/su10010148.

Nasir, J.A., Dang, C., 2019. Quantitative thresholds based decision support approach for the home health care scheduling and routing problem. Health Care Management Science URL: http://link.springer.com/10.1007/s10729-019-09469-1, doi:10.1007/s10729-019-09469-1.

Nasir, J.A., Hussain, S., Dang, C., 2018. An Integrated Planning Approach Towards Home Health Care, Telehealth and Patients Group Based Care. Journal of Network and Computer Applications 117, 30–41. URL: http://www.sciencedirect.com/science/article/pii/S1084804518301711, doi:10.1016/j.jnca.2018.05.009.

Nguyen, T., Montemanni, R., 2016. Integrated home health care optimization via genetic algorithms and mathematical programming. World Congress on Evolutionary Computation (WCEC), Vancouver, Canada , 553–561.

Nickel, S., Schröder, M., Steeg, J., 2012. Mid-term and short-term planning support for home health care services. European Journal of Operational Research 219, 574–587.

Nikzad, E., Bashiri, M., Abbasi, B., 2020. A Matheuristic Algorithm for Stochastic Home Health Care Planning. European Journal of Operational Research doi:10.1016/j.ejor.2020.06.040.

Nozir, S., Catay, B., Unluyurt, T., 2020. Crew Constrained Home Health Care Routing Problem with Time Windows and Synchronized Visits, in: Calisir, F., Korhan, O. (Eds.), Industrial Engineering in the Digital Disruption Era, Springer International Publishing, Cham. pp. 87–96. doi:10.1007/978-3-030-42416-9_9.

Ouertani, N., Nouaouri, I., Ben-Romdhane, H., Allaoui, H., Krichen, S., 2019. A Hypermutation Genetic Algorithm for the Dynamic Home Health-Care Routing Problem, in: 2019 International Conference on Industrial Engineering and Systems Management (IESM), pp. 1–6. doi:10.1109/IESM45758.2019.8948088.

Parragh, S.N., Doerner, K.F., 2018. Solving routing problems with pairwise synchronization constraints. Central European Journal of Operations Research 26, 443–464. doi:10.1007/s10100-018-0520-4.

Petrella, F., et al., 2020. Aide à domicile et services à la personne: les associations dans la tourmente. Presses universitaires de Rennes.

Quintana, D., Cervantes, A., Saez, Y., Isasi, P., 2017. Clustering technique for large-scale home care crew scheduling problems. Applied Intelligence 47, 443–455. doi:10.1007/s10489-017-0908-1.

Quintanilla, S., Ballestín, F., Pérez, , 2020. Mathematical models to improve the current practice in a Home Healthcare Unit. OR Spectrum 42, 43–74. URL: https://doi.org/10.1007/s00291-019-00565-w, doi:10.1007/s00291-019-00565-w.

Rasmussen, M., 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, 598–610.

Redjem, R., Kharraja, S., Xie, X., Marcon, E., 2011. Coordinated multi-criteria scheduling of caregivers in home health care services. IEEE International Conference on Automation Science and Engineering (CASE), Trieste, Italy , 519–524.

Redjem, R., Marcon, E., 2016. Operations management in the home care services: a heuristic for the caregivers' routing problem. Flexible Services and Manufacturing Journal 28, 280–303.

Regis-Hernández, F., Carello, G., Lanzarone, E., 2019. An optimization tool to dimension innovative home health care services with devices and disposable materials. Flexible Services and Manufacturing Journal doi:10.1007/s10696-019-09339-6.

Rest, K.D., Hirsch, P., 2015. Supporting Urban Home Health Care in Daily Business and Times of Disasters. IFAC Symposium onInformation Control Problems inManufacturing - INCOM, Ottawa, Canada 48, 686 – 691.

Rest, K.D., Hirsch, P., 2016. Daily scheduling of home health care services using time-dependent public transport. Flexible Services and Manufacturing Journal , 495–525.

Restrepo, M., Rousseau, L.M., Vallée, J., 2019. Home healthcare integrated staffing and scheduling. Omega-International Journal of Management Science doi:10.1016/j.omega.2019.03.015.

Riazi, S., Chehrazi, P., Wigström, O., Bengtsson, K., Lennartson, B., 2014. A Gossip Algorithm for Home Healthcare Scheduling and Routing Problems. 19th IFAC World Congress, Cape Town, South Africa 47, 10754 – 10759.

Riazi, S., Wigstrom, O., Bengtsson, K., Lennartson, B., 2019. A Column Generation-Based Gossip Algorithm for Home Healthcare Routing and Scheduling Problems, in: IEEE Transactions on Automation Science and Engineering, pp. 127–137. doi:10.1109/TASE.2018.2874392.

Riazi, S., Wigström, O., Bengtsson, K., Lennartson, B., 2018. Decomposition and distributed algorithms for home healthcare routing and scheduling problem, pp. 1–7. doi:10.1109/ETFA.2017.8247622.

Rodriguez, C., Garaix, T., Xie, X., Augusto, V., 2015. Staff dimensioning in homecare services with uncertain demands. International Journal of Production Research 53, 7396–7410.

Ros-McDonnell, L., Szander, N., de-la Fuente-Aragón, M.V., Vodopivec, R., 2019. Scheduling Sustainable Homecare with Urban Transport and Different Skilled Nurses Using an Approximate Algorithm. Sustainability 11, 6210. URL: https://www.mdpi.com/2071-1050/11/22/6210, doi:10.3390/su11226210. number: 22 Publisher: Multidisciplinary Digital Publishing Institute.

Sahin, E., Matta, A., 2015. A contribution to operations management-related issues and models for home care structures. International Journal of Logistics Research and Applications 18, 355–385.

Sahin, E., Vidal, L.A., Benzarti, E., 2013. A framework to evaluate the complexity of home care services. Kybernetes 42, 569–592.

Shahnejat-Bushehri, S., Tavakkoli-Moghaddam, R., Momen, S., Ghasemkhani, A., Tavakkoli-Moghaddam, H., 2019. Home Health Care Routing and Scheduling Problem Considering Temporal Dependencies and Perishability with Simultaneous Pickup and Delivery. IFAC-PapersOnLine 52, 118–123. doi:10.1016/j.ifacol.2019.11.162.

Shao, Y., Bard, J., Jarrah, A., 2012. The therapist routing and scheduling problem. IIE Transactions 44, 868–893.

Shi, Y., Boudouh, T., Grunder, O., 2017a. A Fuzzy Chance-constraint Programming Model for a Home Health Care Routing Problem with Fuzzy Demand:, SCITEPRESS - Science and Technology Publications. pp. 369–376. URL: http://www.scitepress.org/DigitalLibrary/Link.aspx?doi=10.5220/0006194703690376, doi:10.5220/0006194703690376.

Shi, Y., Boudouh, T., Grunder, O., 2017b. A Home Health Care Routing Problem with Stochastic Travel and Service Time. IFAC-PapersOnLine 50, 13987–13992. URL: http://www.sciencedirect.com/science/article/pii/S2405896317332445, doi:10.1016/j.ifacol.2017.08.2419.

Shi, Y., Boudouh, T., Grunder, O., 2017c. A Hybrid Genetic Algorithm for a Home Health Care Routing Problem with Time Window and Fuzzy Demand. Expert Systems with Applications 72, 160 – 176.

Shi, Y., Boudouh, T., Grunder, O., 2019. A robust optimization for a home health care routing and scheduling problem with consideration of uncertain travel and service times. Transportation Research Part E: Logistics and Transportation Review

128, 52–95. URL: http://www.sciencedirect.com/science/article/pii/S136655451831264X, doi:10.1016/j.tre.2019.05.015.

Shi, Y., Boudouh, T., Grunder, O., Wang, D., 2018. Modeling and solving simultaneous delivery and pick-up problem with stochastic travel and service times in home health care. Expert Systems with Applications 102, 218–233. doi:10.1016/j.eswa.2018.02.025.

Sinthamrongruk, T., Dahal, K., Satiya, O., Vudhironarit, T., Yodmongkol, P., 2017. Healthcare Staff Routing Problem using adaptive Genetic Algorithms with Adaptive Local Search and Immigrant Scheme, in: 2017 International Conference on Digital Arts, Media and Technology (ICDAMT), pp. 120–125. doi:10.1109/ICDAMT.2017.7904947.

Sinthamrongruk, T., Dahal, K., Yanchinda, J., 2018. Heuristic and fuzzy scheduling synergy with knowledge acquisition of resource selection system development for home healthcare service. International Journal of Agile Systems and Management 11, 247–269. doi:10.1504/IJASM.2018.094302.

Siu, P., Choy, K., Lam, H., 2018. An intelligent service planning system for effective home care service scheduling. doi:10.23919/PICMET.2018.8481804.

Solomon, M., 1987. Algorithms for the vehicle routing and scheduling problems with time window constraints. Operations Research 35, 254–265.

Szander, N., Ros-McDonnell, L., de la Fuente, M.V., 2019. Algorithm for Efficient and Sustainable Home Health Care Delivery Scheduling, in: Mula, J., Barbastefano, R., Díaz-Madroñero, M., Poler, R. (Eds.), New Global Perspectives on Industrial Engineering and Management, Springer International Publishing, Cham. pp. 315–323. doi:10.1007/978-3-319-93488-4_35.

Szander, N., Ros-McDonnell, L., Victoria de-la Fuente-Aragon, M., Vodopivec, R., 2018a. Sustainable Urban Homecare Delivery with Different Means of Transport. Sustainability 10, 398. doi:10.3390/su10020398.

Szander, N., Ros-McDonnell, L.B., Bogataj, M., 2018b. A Feasible Nurse Routing Plan for the Elderly: Quality and Spatial Trade-Offs, in: Closing the Gap Between Practice and Research in Industrial Engineering. Springer, Cham. Lecture Notes in Management and Industrial Engineering, pp. 201–209. URL: https://link-springer-com.gaelnomade-2.grenet.fr/chapter/10.1007/978-3-319-58409-6_23, doi:10.1007/978-3-319-58409-6_23.

Tohidifard, M., Tavakkoli-Moghaddam, R., Navazi, F., Partovi, M., 2018. A Multi-Depot Home Care Routing Problem with Time Windows and Fuzzy Demands Solving by Particle Swarm Optimization and Genetic Algorithm. IFAC-PapersOnLine 51, 358–363. URL: http://www.sciencedirect.com/science/article/pii/S2405896318314423, doi:10.1016/j.ifacol.2018.08.318.

Trabelsi, S., Larbi, R., Alouane, A.H., 2011. Linear integer programming for the home health care problem. International Conference on Business Process Management (BPM), Clermont-Ferrand, France , 143–151.

Trautsamwieser, A., Gronalt, M., Hirsch, P., 2011. Securing home health care in times of natural disasters. OR Spectrum 33, 787–813.

Trautsamwieser, A., Hirsch, P., 2011. Optimization of daily scheduling for home health care services. Journal of Applied Operational Research 3, 124–136.

Trautsamwieser, A., Hirsch, P., 2014. A Branch-Price-and-Cut approach for solving the medium-term home health care planning problem. Networks 64, 143–159.

Vissers, J., Beech, R., 2005. Health operations management: patient flow logistics in health care. Psychology Press.

Voegl, J., Hirsch, P., 2019. Chapter 18 - The Trade-Off Between the Three Columns of Sustainability: A Case Study From the Home Service Industry, in: Faulin, J., Grasman, S.E., Juan, A.A., Hirsch, P. (Eds.), Sustainable Transportation and Smart Logistics. Elsevier, pp. 467–486. URL: http:

//www.sciencedirect.com/science/article/pii/B9780128142424000181, doi:10.1016/B978-0-12-814242-4.00018-1.

Wirnitzer, J., Heckmann, I., Meyer, A., Nickel, S., 2016. Patient-based nurse rostering in home care. Operations Research for Health Care 8, 91 – 102.

Xiao, L., Dridi, M., El Hassani, A.H., 2018. Mathematical Model for the Home Health Care Scheduling and Routing Problem with Flexible Lunch Break Requirements. IFAC-PapersOnLine 51, 334–339. URL: http://www.sciencedirect.com/science/article/pii/S2405896318314290, doi:10.1016/j.ifacol.2018.08.305.

Xie, Z., Wang, C., 2015. A combinatorial auction for cost reduction in city home health care. 1st International Smart Cities Conference, (ISC2), Guadalajara, Mexico .

Xie, Z., Wang, C., 2017. A periodic repair algorithm for dynamic scheduling in home health care using agent-based model, in: 2017 IEEE 21st International Conference on Computer Supported Cooperative Work in Design (CSCWD), pp. 245–250. doi:10.1109/CSCWD.2017.8066702.

Yalçındag, S., Cappanera, P., Scutellà, M., Sahin, E., Matta, A., 2016a. Pattern-based decompositions for human resource planning in home health care services. Computers & Operations Research 73, 12 – 26.

Yalçındag, S., Matta, A., Sahin, E., Shanthikumar, J.G., 2016b. The patient assignment problem in home health care: using a data-driven method to estimate the travel times of care givers. Flexible Services and Manufacturing Journal 28, 304–335.

Yalçındağ, S., Matta, A., 2017. A decomposition approach for the home health care problem with time windows, pp. 221–232. doi:10.1007/978-3-319-66146-9_20.

Yang, X., Zhang, T., Mao, N., Chen, Q., Bai, L., Chen, W., 2018. The Stochastic Home Health Care Routing Problem in Dense Communities with Multi-Appointment, in: 2018 15th International Conference on Service Systems and Service Management (ICSSSM), pp. 1–6. doi:10.1109/ICSSSM.2018.8464971.

Yuan, B., Jiang, Z., 2017. Disruption Management for the Real-Time Home Caregiver Scheduling and Routing Problem. Sustainability 9, 2178. doi:10.3390/su9122178.

Yuan, B., Liu, R., Jiang, Z., 2014. Home health care crew scheduling and routing problem with stochastic service times. IEEE International IEEE Conference on Automation Science and Engineering (CASE), New Taipei, Taiwan , 564–569.

Yuan, B., Liu, R., Jiang, Z., 2015. A branch-and-price algorithm for the home health care scheduling and routing problem with stochastic service times and skill requirements. International Journal of Production Research 53, 7450–7464.

Yuan, B., Liu, R., Jiang, Z., 2018. Daily scheduling of caregivers with stochastic times. International Journal of Production Research 56, 3245–3261. URL: https://doi.org/10.1080/00207543.2018.1445879, doi:10.1080/00207543.2018.1445879.

Zhan, Y., Wan, G., 2018. Vehicle routing and appointment scheduling with team assignment for home services. Computers and Operations Research 100, 1–11. doi:10.1016/j.cor.2018.07.006.

Zhan, Y., Wang, Z., Wan, G., 2020. Home service routing and appointment scheduling with stochastic service times. European Journal of Operational Research doi:10.1016/j.ejor.2020.05.037.

Zhang, L., Bouchet, P.Y., Lamine, E., Fontanili, F., Bortolaso, C., Derras, M., Pingaud, H., 2019. Home Health Care Daily Planning Considering the Satisfaction of all the Stakeholders, in: 2019 International Conference on Industrial Engineering and Systems Management (IESM), pp. 1–6. doi:10.1109/IESM45758.2019.8948201.

Zhang, T., Yang, X., Chen, Q., Bai, L., Chen, W., 2018. Modified ACO for home health care scheduling and routing problem in Chinese communities, in: 2018 IEEE 15th International Conference on Networking, Sensing and Control (ICNSC), pp. 1–6. doi:10.1109/ICNSC.2018.8361373.

Zhu, Y., Matta, A., Lanzarone, E., Geng, N., 2019. A Variable Neighborhood Search for Home Care Scheduling Under Chargeable Overtime and Preference Matching*,

in: 2019 IEEE 15th International Conference on Automation Science and Engineering (CASE), pp. 281–286. doi:10.1109/COASE.2019.8843276. iSSN: 2161-8089.

Table 2: Considered problem (Journal papers)

Year	First Author	References	Publication			Studied problem				
			Journal title	Affiliation	Application	Type of study		Horizon		Uncertainties
						Case study	Review	Short	Long	
1997	begur	Begur et al. (1997)	Interfaces	USA	USA	√	-	-	√	-
2000	hindle	Hindle et al. (2000)	HSMR	UK	Irland	√	-	√	-	-
2006	bertels	Bertels and Fahle (2006)	C&OR	Germany	-	-	-	√	-	-
2006	eveborn	Eveborn et al. (2006)	EJOR	Sweden	Sweden	√	-	√	-	-
2007	akjiratikarl	Akjiratikarl et al. (2007)	C&OR	Thailand	UK	√	-	√	-	-
2008	bredstrom	Bredström and Rönnqvist (2008)	EJOR	Norway	-	-	-	√	-	-
2009	chahed	Chahed et al. (2009)	HCMS	UK	-	-	-	-	√	-
2009	hindle	Hindle et al. (2009)	HSMR	UK	UK	√	-	√	-	-
2011	ben bachouch	Ben Bachouch et al. (2011)	Supply Chain Forum	France	-	-	-	-	√	-
2011	bennett	Bennett and Erera (2011)	IIE Trans. on HCSE	USA	-	-	-	-	√	√
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	JAOR	Austria	Austria	√	-	√	-	-
2011	trautsamwieser	Trautsamwieser et al. (2011)	OR spectrum	Austria	-	-	-	√	-	-
2012	an	An et al. (2012)	JORS	Korea	Korea	√	-	-	√	-
2012	nickel	Nickel et al. (2012)	EJOR	Germany	Denmark	√	-	-	√	√
2012	rasmussen	Rasmussen et al. (2012)	EJOR	Denmark	Denmark	√	-	√	-	-
2012	shao	Shao et al. (2012)	IIE Trans.	USA	-	-	-	-	√	-
2013	allaoua	Allaoua et al. (2013)	Elec. Notes in Disc Math.	France	-	-	-	√	-	-
2013	bard	Bard et al. (2013)	SEPS	USA	-	-	-	-	√	-
2013	cappanera	Cappanera and Scutellà (2013)	Elec. Notes in Disc Math.	Italy	Italy	√		-	√	-
2013	mutingi	Mutingi and Mbohwa (2013a)	Lect. Notes Eng. Comp.	South africa	-	-	-	√	-	-
2013	sahin	Sahin et al. (2013)	Kybernetes	France	-	-	√			
2014	bard	Bard et al. (2014a)	J. Sched	USA	USA	√	-	-	√	-
2014	bard	Bard et al. (2014b)	IIE Trans.	USA	-	-	-	-	√	-
2014	cappanera	Cappanera and Scutellà (2014)	Transportation Science	Italy	-	-	-	-	√	√
2014	carello	Carello and Lanzarone (2014)	EJOR	Italy	-	-	-	-	√	√
2014	di gaspero	Di Gaspero and Urli (2014)	Lect. Notes Comp. Sci.	Italy	-	-	-	-	√	-
2014	lanzarone	Lanzarone and Matta (2014)	ORHC	Italy	Italy	√	-	√	-	√
2014	mankowska	Mankowska et al. (2014)	HCMS	Germany	-	-	-	√	-	-
2014	mutingi	Mutingi and Mbohwa (2014)	IIE Trans. on HCSE	South africa	-	-	-	√	-	-
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	Networks	Austria	-	-	-	-	√	-
2015	bowers	Bowers et al. (2015)	HCMS	UK	-	-	-	-	√	-
2015	fikar	Fikar and Hirsch (2015)	J. Clean. Prod	Austria	Austria	√	-	√	-	-
2015	hiermann	Hiermann et al. (2015)	Central EJOR	Austria	Austria	√	-	√	-	-
2015	issaoui	Issaoui et al. (2015a)	Elec. Notes in Disc Math.	Tunisia	-	-	-	√	-	-
2015	lieder	Lieder et al. (2015)	ORHC	Germany	Netherlands	√	-	√	-	-
2015	maya duque	Maya Duque et al. (2015)	EJOR	Belgium	Belgium	√	-	-	√	-
2015	misir	Mısır et al. (2015)	JORS	Belgium	-	-	-	√	-	-
2015	rodriguez	Rodriguez et al. (2015)	IJPR	France	France	√	-	-	√	√
2015	sahin	Sahin and Matta (2015)	Int. J. Logist-Res. App.	France	-	-	√			
2015	yuan	Yuan et al. (2015)	IJPR	China	-	-	-	√	-	√
2016	ait haddadene	Ait Haddadene et al. (2016a)	ESWA	France	-	-	-	√	-	-
2016	braekers	Braekers et al. (2016)	EJOR	Belgium	-	-	-	√	-	-
2016	fikar	Fikar et al. (2016)	European J. Indus. Eng.	Austria	-	-	-	-	-	√
2016	heching	Heching and Hooker (2016)	Lect. Notes Comp. Sci.	USA	USA	√	-	-	√	√
2016	lin	Lin et al. (2016)	ESWA	Hong Kong	Hong Kong	√	-	-	√	-
2016	redjem	Redjem and Marcon (2016)	FSM	France	-	-	-	√	-	-
2016	rest	Rest and Hirsch (2016)	FSM	Austria	Austria	√	-	√	-	-
2016	wirnitzer	Wirnitzer et al. (2016)	ORHC	Germany	Germany	√	-	-	√	-
2016	yalcindag	Yalçındag et al. (2016b)	FSM	Italy	Italy	√	-	√	-	√
2016	yalcindag	Yalçındag et al. (2016a)	C&OR	Turkey	Italy	√	-	√	-	-
2017	cappanera	Cappanera et al. (2017)	Omega	Italy	-	-	-	-	√	√
2017	cisse	Cissé et al. (2017)	ORHC	France	-	-	√			
2017	du	Du et al. (2017b)	J. Comb Optim	China	China	√	-	-	√	√
2017	du	Du et al. (2017a)	Sustainability	China	China	√	-	-	√	-
2017	erdem	Erdem and Bulkan (2017)	S. Afr. J. Ind. Eng	Turkey	-	-	-	√	-	-
2017	fikar	Fikar and Hirsch (2017)	C&OR	Austria	-	-	√			
2017	frifita	Frifita et al. (2017)	Elec. Notes in Disc Math.	France	-	-	-	√	-	-
2017	guericke	Guericke and Suhl (2017)	OR Spectrum	Germany	-	-	-	-	√	-
2017	liu	Liu et al. (2017)	IJPR	China	China	√	-	-	√	-
2017	luna	Luna et al. (2017)	Cluster comput.	Spain	Spain	√	-	-	√	-
2017	marcon	Marcon et al. (2017)	Simul. Model. Pract. Th.	France	France	√	-	√	-	√
2017	quintana	Quintana et al. (2017)	Appl. Intell.	Spain	Spain	√	-	-	√	-
2017	shi	Shi et al. (2017c)	ESWA	France	-	-	-	√	-	√
2017	yuan	Yuan and Jiang (2017)	Sustainability	China	China	√	-	-	√	√
2018	carello	Carello et al. (2018)	ORHC	Italy	Italy	√	-	-	√	√
2018	decerle	Decerle et al. (2018b)	ORHC	France	France	√	-	√	-	-
2018	demirbilek	Demirbilek et al. (2018)	HCMS	UK	-	-	-	-	√	√
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	J. Clean. Prod	Iran	-	-	-	√	-	-
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	IJE	Iran		-	-	√	-	-
2018	fikar	Fikar and Hirsch (2018)	FSM	Austria	Austria	√	-	√	-	-
2018	hirsch	Hirsch (2018)	Die Bodenkultur J.L.M.F.E.	Austria	-	-	√			
2018	lin	Lin et al. (2018)	C&IE	Taiwan	-	-	-	-	√	√
2018	liu	Liu et al. (2018)	Comp. Appl. Math.	China	-	-	-	-	√	-
2018	mosquera	Mosquera et al. (2018)	Omega	Belgium	Belgium	√	-	-	√	√
2018	nasir	Nasir and Dang (2018)	Sustainability	China	-	-	-	-	√	√
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	Int J. Agile Systems and Management	UK	-	-	-	√	-	-
2018	szander	Szander et al. (2018b)	Lect. Notes Manag. Ind. Eng	Slovenia	Hungary	√	-	√	-	-
2018	szander	Szander et al. (2018a)	Sustainability	Slovenia	-	√	-	-	√	-
2018	yuan	Yuan et al. (2018)	IJPR	China	-	-	-	√	-	√
2018	zhan	Zhan and Wan (2018)	C&OR	China	-	-	-	√	-	√
2019	becker	Becker et al. (2019)	Lect. Notes Comp. Sci.	Germany	-	-	√			
2019	chaieb	Chaieb et al. (2019)	HCMS	Saudi Arabia	New Zealand	√	-	√	-	-
2019	decerle	Decerle et al. (2019a)	Swarm and Evolutionary Computation	France	-	-	-	√	-	-
2019	decerle	Decerle et al. (2019b)	Swarm and Evolutionary Computation	France	-	-	-	√	-	-
2019	dekhici	Dekhici et al. (2019)	Canadian J. of Elec. And Computer Eng.	Algeria	-	-	-	√	-	-
2019	demirbilek	Demirbilek et al. (2019)	FSM	UK	-	-	-	-	√	√
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	Neural Computing and Applications	Iran	-	-	-	√	-	-
2019	gomes	Gomes and Ramos (2019)	EJOR	Portugal	Portugal	√	-	-	√	√
2019	grenouilleau	Grenouilleau et al. (2019)	EJOR	Canada	-	-	-	-	√	-
2019	heching	Heching et al. (2019)	Transportation Science	USA	-	-	-	-	√	-
2019	liu	Liu et al. (2019a)	C&OR	China	-	-	-	√	-	-
2019	liu	Liu et al. (2019b)	FSM	China	-	-	-	-	√	√
2019	moussavi	Moussavi et al. (2019)	ESWA	France	-	-	-	-	√	-
2019	nasir	Nasir and Dang (2019)	HCMS	Hong Kong	-	-	-	√	-	√
2019	restrepo	Restrepo et al. (2019)	Omega	Canada	-	-	-	-	√	√
2019	riazi	Riazi et al. (2019)	IEEE TASE	Sweden	-	-	-	√	-	-
Sum						38	6	46	43	27
Percentage (%)						39.58	6.32	51.11	47.78	30.00

Table 3: Considered problem (Journal papers) - 2

Year	First Author	References	Modeling and Resolution approach	Instances	
				Benchmark	Instances size (max)
1997	begur	Begur et al. (1997)	Heuristic	-	7 SM - 200 V
2000	hindle	Hindle et al. (2000)	Heuristic	-	-
2006	bertels	Bertels and Fahle (2006)	CP-TS and CP-SA and CP-LP	-	50 SM - 200 Pa - 600 V
2006	eveborn	Eveborn et al. (2006)	Repeated matching algorithm	-	123 Pa - 20 SM
2007	akjiratikarl	Akjiratikarl et al. (2007)	MILP – PSO	-	100 Pa -12 SM
2008	bredstrom	Bredström and Rönnqvist (2008)	MILP – B&P	-	90 Pa -16 SM
2009	chahed	Chahed et al. (2009)	MILP	-	-
2009	hindle	Hindle et al. (2009)	Heuristic	-	125 Pa - 23 districts
2011	ben bachouch	Ben Bachouch et al. (2011)	MILP	-	7 SM - 20 Pa
2011	bennett	Bennett and Erera (2011)	Rolling horizon planning approach	-	-
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	MILP - VNS	-	512 V - 420 Pa - 75 SM
2011	trautsamwieser	Trautsamwieser et al. (2011)	MILP - VNS – LS	-	75 SM - 512 V
2012	an	An et al. (2012)	2 phase heuristic approach - mip	-	20 Pa -1 SM
2012	nickel	Nickel et al. (2012)	ALNS - CP	-	361 Pa - 12 SM
2012	rasmussen	Rasmussen et al. (2012)	MILP – B&P	Bredström and Rönnqvist (2008)	15 V -150 Pa
2012	shao	Shao et al. (2012)	GRASP – ALNS	-	-
2013	allaoua	Allaoua et al. (2013)	MILP – Matheuristic	Kergosien et al. (2014)	30 Pa - 9 SM
2013	bard	Bard et al. (2013)	MILP	-	20 SM - 280 Pa
2013	cappanera	Cappanera and Scutellà (2013)	MILP	-	163 Pa
2013	mutingi	Mutingi and Mbohwa (2013a)	MILP – Genetic algorithm	-	-
2014	bard	Bard et al. (2014a)	MILP – GRASP	-	45 Pa
2014	bard	Bard et al. (2014b)	MILP – DA - B&P - B&C	-	-
2014	cappanera	Cappanera and Scutellà (2014)	-	Nickel et al. (2012)	11 SM- 162 V
2014	carello	Carello and Lanzarone (2014)	CC	Lanzarone and Matta (2014)	-
2014	di gaspero	Di Gaspero and Urli (2014)	CP - adaptive LNS	-	32 SM - 40 V/day
2014	lanzarone	Lanzarone and Matta (2014)	-	-	-
2014	mankowska	Mankowska et al. (2014)	AVNS - MILP	-	300 Pa - 40 SM
2014	mutingi	Mutingi and Mbohwa (2014)	MILP – FSE	Trabelsi et al. (2011)	-
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	B&P&C - VNS - MILP	-	45 Pa - 9 SM - 203 V
2015	bowers	Bowers et al. (2015)	C&W	-	6 SM - 168 V
2015	fikar	Fikar and Hirsch (2015)	2 stage Matheuristics	-	125 V
2015	hiermann	Hiermann et al. (2015)	two stage approach: MILP- CP (MA, SAHH, SS, VNS)	-	518 SM - 717 V
2015	issaoui	Issaoui et al. (2015a)	3 phase metaheuristic based on VND and LPT - MILP	Trautsamwieser and Hirsch (2011)	30 Pa - 4 SM
2015	lieder	Lieder et al. (2015)	DP - mip	-	5 SM - 42 V
2015	maya duque	Maya Duque et al. (2015)	2 stage approach (set partitioning) - MILP	-	109 Pa- 21 SM - 562 V
2015	misir	Mısır et al. (2015)	-	-	-
2015	rodriguez	Rodriguez et al. (2015)	MILP – 2 stage approach	-	-
2015	yuan	Yuan et al. (2015)	MILP – CG- B-P	Solomon (1987)	-
2016	ait haddadene	Ait Haddadene et al. (2016a)	MILP – GRASP-ILS	Bredström and Rönnqvist (2008)	73 Pa - 16 SM
2016	braekers	Braekers et al. (2016)	MILP – epsilon-const - ALNS	Hiermann et al. (2015)	171 Pa - 89 SM - 300 V
2016	fikar	Fikar et al. (2016)	Matheuristic	Fikar and Hirsch (2015) ;	125V
2016	heching	Heching and Hooker (2016)	MIP - CP – LBBD	-	60 Pa - 18 SM
2016	lin	Lin et al. (2016)	MILP	-	560 Pa - 12 SM - 643 V
2016	redjem	Redjem and Marcon (2016)	Heuristics	-	60 Pa - 30 SM
2016	rest	Rest and Hirsch (2016)	MILP – TS	-	127 Pa - 46 SM - 202 V
2016	wirnitzer	Wirnitzer et al. (2016)	MIP Approach	-	143 Pa - 37 SM - 1114 V/week
2016	yalcindag	Yalçındag et al. (2016b)	MILP – 2 stage approach	-	-
2016	yalcindag	Yalçındag et al. (2016a)	Two-phase approach	-	300 Pa - 16 SM - 557 V
2017	cappanera	Cappanera et al. (2017)	CC	-	3 SM - 60 Pa
2017	du	Du et al. (2017b)	IMA	-	50 Pa
2017	du	Du et al. (2017a)	GA-LS	-	-
2017	erdem	Erdem and Bulkan (2017)	MILP-VNS	Hiermann et al. (2015)	-
2017	frifita	Frifita et al. (2017)	G-VNS	Bredström and Rönnqvist (2008)	16 SM - 80 V
2017	guericke	Guericke and Suhl (2017)	MILP - ALNS	Trautsamwieser and Hirsch (2014) ; Cappanera and Scutellà (2013) ; Cappanera and Scutellà (2014)	-
2017	liu	Liu et al. (2017)	MILP - B&P	Solomon (1987)	100 Pa - 12 SM
2017	luna	Luna et al. (2017)	EA	-	374 SM
2017	marcon	Marcon et al. (2017)	Sim - MaS	-	130 SM - 300 Pa
2017	quintana	Quintana et al. (2017)	Heuristics - CM	-	9365 Pa
2017	shi	Shi et al. (2017c)	MILP Genetic	Solomon (1987)	-
2017	yuan	Yuan and Jiang (2017)	TS	-	9 SM - 50 Pa
2018	carello	Carello et al. (2018)	CC	-	
2018	decerle	Decerle et al. (2018b)	MA	Bredström and Rönnqvist (2008)	80V
2018	demirbilek	Demirbilek et al. (2018)	SBA	-	-
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	MILP - Heuristics - memetic Metaheuristics - epsilon constraint	-	20 SM - 200 Pa - 8 types of vehicles
2018	fikar	Fikar and Hirsch (2018)	event-driven biased-randomised Heuristic and Matheuristic	Fikar and Hirsch (2015) ; Solomon (1987)	100 Pa - 125 V
2018	lin	Lin et al. (2018)	Metaheuristic	-	38 SM - 95 Pa - 361 V
2018	liu	Liu et al. (2018)	epsilon constraint method, heuristics	-	18 SM - 65 Pa
2018	mosquera	Mosquera et al. (2018)	IP-LS	-	28 SM - 127 Pa
2018	nasir	Nasir and Dang (2018)	VNS	-	91 SM - 260
2018	szander	Szander et al. (2018b)	MILP	-	9 SM - 56 Pa
2018	szander	Szander et al. (2018a)	Heuristic	-	11 SM - 73 Pa
2018	yuan	Yuan et al. (2018)	B&P	-	9 SM - 50 Pa
2018	zhan	Zhan and Wan (2018)	scenario-based MIP - heuristic based on TS	-	40 Pa
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	MILP-Lagrangian relaxation-based algorithm	-	20 SM - 200 Pa - 8 types of vehicles
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	Fuzzy logic - heuristic	-	8SM - 40 V
2019	chaieb	Chaieb et al. (2019)	MILP - k-means - hungarian algorithm - TS	Rasmussen et al. (2012)	15 SM - 154 V
2019	decerle	Decerle et al. (2019a)	MILP-MA- ACO	Bredström and Rönnqvist (2008)	20 SM, 80V
2019	decerle	Decerle et al. (2019b)	MILP- MAMO- trade off analysis	Bredström and Rönnqvist (2008)	20 SM, 80V
2019	dekhici	Dekhici et al. (2019)	Firefly algorithm	-	4 SM- 20 V
2019	demirbilek	Demirbilek et al. (2019)	SBA	-	
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	Lagrangian relaxation-based algorithm - Heuristics	-	20 SM - 200 Pa - 8 types of vehicles
2019	gomes	Gomes and Ramos (2019)	MILP	-	9 SM - 190 Pa
2019	grenouilleau	Grenouilleau et al. (2019)	Heuristic - LNS	-	20 SM - 150 Pa - 430 V
2019	heching	Heching et al. (2019)	LBBD - MILP- CP	Rasmussen et al. (2012)	60 Pa - 270 V
2019	liu	Liu et al. (2019a)	ANS	Solomon (1987), Gehring and Homberger (1999)	200 Pa
2019	liu	Liu et al. (2019b)	MILP - B&P	-	9 SM - 50 Pa
2019	moussavi	Moussavi et al. (2019)	Matheuristic	-	10 SM - 30 Pa
2019	nasir	Nasir and Dang (2019)	MILP-VNS- ROC Curves	-	120 SM-300 Pa
2019	restrepo	Restrepo et al. (2019)	Context-free grammar, Stochastic programming	-	500V
2019	riazi	Riazi et al. (2019)	gossip algorithm, CG, Dantzig Wolf Decomposition, MILP	Solomon (1987),Gehring and Homberger (2002)	200 Pa
Sum				23	
Percentage(%)				25.56	

V: Visits; **SM:** Staff member; **Pa:** Patients;
ALNS: Adaptive Large Neighborhood Search; **ANS:** Adaptive Neighborhood Search; **BB:** Branch & Bound; **BD:** Bender Decomposition; **BP:** Branch & Price; **BPC:** Branch & Price & Cut; **CC:** Cardinality Constraints; **CG:** Column Generation; **CP:** Constraints Programming; **CW:** Clarke & Wright; **DA:** Decomposition Approach; **DP:** Dynamic Programming; ε **C:** ε-Constraints; **2S:** 2 Stage; **FSE:** Fuzzy Simulated Evolutionary; **GA:** Genetic Algorithm; **GRASP:** Greedy Randomized Adaptive Search Procedure; **ILS:** Iterated Local Search ; **LNS:** Large Neighborhood Search; **LBBD:** Logic Based Benders Decomposition; **LS:** Local Search; **MA:** Memetic Algorithm; **MAMO :** Memetic Algorithm for Evolutionary Multiobjective Optimization; **MaS:** Multi-agent System; **MILP:** Mixed Integer Linear Programming; **PSO:** Particle Swarm Optimization; **ROC:** Receiver Operating Characteristic **RHP:** Rolling Horizon Planning; **RMA:** Repeated Matching Algorithm; **SA:** Simulated Annealing; **Sim:** Simulation; **SS:** Scatter Search; **TS:** Tabu Search; **VND:** Variable Neighborhood Descent; **VNS:** Variable Neighborhood Search ;

Table 4: Considered problem (Conference papers) - 1

Year	First author	References	Publication			Studied problem				
			Conference name	Affiliation	Application	Type of study		Horizon		Uncertainties
						Case study	Review	Short	Long	
2006	borsani	Borsani et al. (2006)	ICSSSM	Italy	Italy	√	-	-	√	-
2008	elbenani	Elbenani et al. (2008)	IEEM	Morroco	Canada	√	-	√	-	-
2009	kergosien	Kergosien et al. (2009)	MISTA	France	-	-	-	√	-	-
2010	misir	Mısır et al. (2010)	CEC	Belgium	-	-	-	-	√	-
2011	redjem	Redjem et al. (2011)	CASE	France	-	-	-	√	-	-
2012	bashir	Bashir et al. (2012)	MOSIM	France	-	-	√			
2012	cattafi	Cattafi et al. (2012)	ICLP	Italy	Italy	√	-	√	-	-
2012	gamst	Gamst and Jensen (2012)	Op. Res. Proc.	Denmark	Denmark	√	-	-	√	-
2012	gutierrez	Gutiérrez and Vidal (2012)	IEOM	Colombia	-	-	√			
2013	errarhout	Errarhout et al. (2013)	IESM	France	-	-	-	-	√	-
2013	gayraud	Gayraud et al. (2013)	ProcediaTech.	France	-	-	-	-	√	-
2013	jemai	Jemai et al. (2013)	ICMSAO	Saoudi Arabia	-	-	-	√	-	-
2013	luna	Luna et al. (2013)	3PGCIC	Spain	Spain	√	-	-	√	-
2013	mutingi	Mutingi and Mbohwa (2013b)	IEEM	South Africa	-	-	√			
2014	cappanera	Cappanera et al. (2014)	HCSE	Italy	-	-	-	-	√	√
2014	di mascolo	Di Mascolo et al. (2014)	HCSE	France	France	√	-	√	-	-
2014	espinouse	Espinouse et al. (2014)	CIE	France	France	√	-	√	-	-
2014	kergosien	Kergosien et al. (2014)	HCSE	France	-	-	-	-	√	-
2014	labadie	Labadie et al. (2014)	ICORES	France	-	-	-	√	-	-
2014	masmoudi	Masmoudi and Mellouli (2014)	CoDIT	France	-	-	-	√	-	-
2014	riazi	Riazi et al. (2014)	IFAC	Sweden	-	-	-	√	-	-
2014	yuan	Yuan et al. (2014)	CASE	China	-	-	-	-	√	√
2015	aiane	Aiane et al. (2015)	IESM	France	-	-	-	√	-	-
2015	cattafi	Cattafi et al. (2015)	AI Comm.	Italy	Italy	√	-	-	√	-
2015	en-nahli	En-nahli et al. (2015)	IFAC	France	-	-	-	√	-	-
2015	issaoui	Issaoui et al. (2015b)	ISDA	France	-	-	√			
2015	laesanklang	Laesanklang et al. (2015)	ICORES	UK	UK	√	-	√	-	-
2015	rest	Rest and Hirsch (2015)	IFAC	Austria	Austria	√	-	√		√
2015	xie	Xie and Wang (2015)	ISC2	Canada	-	-	-	√	-	-
2016	ait haddadene	Ait Haddadene et al. (2016b)	IFAC	France	-	-	-	√	-	-
2016	decerle	Decerle et al. (2016)	IFAC	France	-	-	-	√	-	-
2016	en-nahli	En-nahli et al. (2016)	IFAC	France	-	-	-	√	-	-
2016	manerba	Manerba and Mansini (2016)	IFAC	Italy	-	-	-	√	-	-
2016	nguyen	Nguyen and Montemanni (2016)	WCEC	Switzerland	Switzerland	√	-	-	√	√
2017	alves	Alves et al. (2017)	ICCSA	Portugal	Portugal	√	-	√	-	-
2017	baumann	Baumann (2017)	IEEM	Switzerland	Switzerland	√	-	-	√	-
2017	carello	Carello et al. (2017)	HCSE	Italy	-	-	-	-	√	√
2017	chen	Chen et al. (2017)	ICAPS	Singapore	USA	√	-	-	√	√
2017	decerle	Decerle et al. (2017)	CODIT	France	-	-	-	√	-	-
2017	di mascolo	Di Mascolo et al. (2017b)	HCSE	France	France	√	-	-	√	√
2017	di mascolo	Di Mascolo et al. (2017a)	IFAC	France	-	-	√			
2017	el hajri	El Hajri et al. (2017)	IFAC	France	France	√	-	-	√	-
2017	emiliano	Emiliano et al. (2017)	MESIC	Portugal	Portugal/Brazil	-	√			
2017	gunawan	Gunawan et al. (2017)	MISTA	Singapore	-	-	-	√	-	√
2017	lahrichi	Lahrichi et al. (2017)	HCSE	Canada	-	-	-	-	√	-
2017	naji	Naji et al. (2017)	CODIT	France	-	-	-	√	-	√
2017	shi	Shi et al. (2017a)	ICORES	France	-	-	-	√	-	√
2017	shi	Shi et al. (2017b)	IFAC	France	-	-	-	√	-	√
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	ICDAMT	UK	-	-	-	√	-	-
2017	xie	Xie and Wang (2017)	CSCWD	Canada	-	-	-	√	-	√
2017	yalcindag	Yalçındağ and Matta (2017)	HCSE	Turkey	-	-	-	-	√	-
2018	alves	Alves et al. (2018b)	BIOMA	Portugal	Portugal	√	-	-	√	-
2018	alves	Alves et al. (2018a)	PAAMS	Portugal	Portugal	√	-	√	-	√
2018	decerle	Decerle et al. (2018c)	IFAC	France	-	-	-	√	-	-
2018	decerle	Decerle et al. (2018a)	IFAC	France	-	-	-	√	-	-
2018	di mascolo	Di Mascolo et al. (2018)	IFAC	France	-	-	-	√	-	-
2018	eliseu	Eliseu et al. (2018)	APDIO	Portugal	Portugal	√	-	√	-	-
2018	feng	Feng and Wang (2018)	ICSSSM	China	China	√	-	√	-	-
2018	garaix	Garaix et al. (2018)	IFAC	France	-	-	-	√	-	-
2018	martinez	Martinez et al. (2018)	CODIT	France	-	-	-	-	√	-
2018	riazi	Riazi et al. (2018)	ETFA	Sweden	-	-	-	√	-	-
2018	siu	Siu et al. (2018)	PICMET	Hong Kong	Hong Kong	√	-	√	-	-
2018	tohidifard	Tohidifard et al. (2018)	IFAC	Iran	-	-	-	√	-	√
2018	Xiao	Xiao et al. (2018)	IFAC	France	France	√	-	-	√	-
2018	yang	Yang et al. (2018)	ICSSSM	China	-	-	-	√	-	√
2018	zhang	Zhang et al. (2018)	ICNSC	China	China	√	-	√	-	√
2019	alves	Alves et al. (2019b)	ICORES	Portugal	Portugal	√	-	√	-	-
2019	alves	Alves et al. (2019a)	ICORES	Portugal	Portugal	√	-	-	√	-
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	APDIO	Portugal	Portugal	√	-	√	-	-
Sum						26	6	41	22	16
Percentage (%)						37.68	8.70	65.08	35.48	25.40
Global Sum						64	12	87	65	43
Global Percentage (%)						38.79	7.27	56.86	42.76	28.10

Table 5: Considered problem (Conference papers) - 2

Year	First author	References	Modeling and Resolution approach	Instances	
				Benchmark	Instances size
2006	borsani	Borsani et al. (2006)	MILP	-	382 Pa - 25 SM
2008	elbenani	Elbenani et al. (2008)	MILP – TS	-	-
2009	kergosien	Kergosien et al. (2009)	MILP	-	40 V
2010	misir	Mısır et al. (2010)	MILP – Heuristics	-	-
2011	redjem	Redjem et al. (2011)	MILP	-	14 Pa - 4 SM
2012	cattafi	Cattafi et al. (2012)	-	-	-
2012	gamst	Gamst and Jensen (2012)	MILP – BP	-	-
2013	errarhout	Errarhout et al. (2013)	MILP	-	-
2013	gayraud	Gayraud et al. (2013)	MILP	-	30 Pa - 4 SM
2013	jemai	Jemai et al. (2013)	MILP – Tabu search	-	-
2013	luna	Luna et al. (2013)	MILP	-	10654 V - 1375 Pa
2014	cappanera	Cappanera et al. (2014)	Sim - MILP	-	6 SM - 80 Pa
2014	di mascolo	Di Mascolo et al. (2014)	MILP	-	-
2014	espinouse	Espinouse et al. (2014)	MILP	-	64 V - 30 SM - 80 Pa
2014	kergosien	Kergosien et al. (2014)	MILP - TS-VNS	-	250 Pa - 20 SM - 5 labo
2014	labadie	Labadie et al. (2014)	MILP – ILS	Bredström and Rönnqvist (2008)	16 SM - 45 Pa
2014	masmoudi	Masmoudi and Mellouli (2014)	MILP – 2 stage MILP Heuristic	-	88 V - 15 SM - 50 Pa
2014	riazi	Riazi et al. (2014)	MILP - Gossip algorithm and Relaxation	-	30 V - 5 SM
2014	yuan	Yuan et al. (2014)	MILP – B&P&C – CG	Solomon (1987)	-
2015	aiane	Aiane et al. (2015)	MILP	-	15 Pa - 5 SM
2015	cattafi	Cattafi et al. (2015)	CP - LNS with restart	-	-
2015	en-nahli	En-nahli et al. (2015)	MILP	-	40 Pa - 8 SM
2015	laesanklang	Laesanklang et al. (2015)	MILP – DA	-	1011 SM - 1726 V
2015	rest	Rest and Hirsch (2015)	TS based metaheuristic	-	46 SM - 202 V
2015	xie	Xie and Wang (2015)	MILP	-	-
2016	ait haddadene	Ait Haddadene et al. (2016b)	NSGAII	Bredström and Rönnqvist (2008)	16 SM - 73 Pa
2016	decerle	Decerle et al. (2016)	MIP – Two phase Matheuristic	-	60 V
2016	en-nahli	En-nahli et al. (2016)	MILP – RVND-ILS	Bredström and Rönnqvist (2008)	20 Pa - 4 SM
2016	manerba	Manerba and Mansini (2016)	MILP – B&P	-	12 SM - 15 Pa - 20 V
2016	nguyen	Nguyen and Montemanni (2016)	MILP – GA	-	
2017	alves	Alves et al. (2017)	GA-PSO	-	12SM-31Pa
2017	baumann	Baumann (2017)	MILP	-	-
2017	carello	Carello et al. (2017)	IAA	-	98 Pa
2017	chen	Chen et al. (2017)	MILP-SAA-LR	-	199 SM - 2062 Pa
2017	decerle	Decerle et al. (2017)	MA	Bredström and Rönnqvist (2008)	80 Pa
2017	di mascolo	Di Mascolo et al. (2017b)	2OPT-Heuristic	-	10 SM
2017	el hajri	El Hajri et al. (2017)	MILP	-	4 SM-14 Pa
2017	gunawan	Gunawan et al. (2017)	ILS	-	4 SM - 228 Pa
2017	lahrichi	Lahrichi et al. (2017)	DA	-	20 SM -300 Pa
2017	naji	Naji et al. (2017)	MILP	-	15 SM
2017	shi	Shi et al. (2017a)	FCCP- HGA	A-series	-
2017	shi	Shi et al. (2017b)	SPR-HGA	-	25 Pa
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	GA-ALS	-	-
2017	xie	Xie and Wang (2017)	Sim-Repair Method	-	-
2017	yalcindag	Yalçındağ and Matta (2017)	MILP- DA	-	2 SM- 15 Pa
2018	alves	Alves et al. (2018b)	GA	-	78V
2018	alves	Alves et al. (2018a)	MaS - GA	-	5 SM - 15 Pa
2018	decerle	Decerle et al. (2018c)	MILP - multidimensional LS	Bredström and Rönnqvist (2008)	80 V
2018	decerle	Decerle et al. (2018a)	MILP - Matheuristic	Solomon (1987)	50 Pa
2018	di mascolo	Di Mascolo et al. (2018)	MILP	-	18 SM - 30 Pa
2018	eliseu	Eliseu et al. (2018)	Greedy heuristic, biased (randomization process, local search, MIRHA approach)	-	6 SM - 23 Pa
2018	feng	Feng and Wang (2018)	MILP	-	-
2018	garaix	Garaix et al. (2018)	MILP	-	177 SM - 1077 V
2018	martinez	Martinez et al. (2018)	MILP-Heuristic	-	35 SM - 200 Pa -742 V
2018	riazi	Riazi et al. (2018)	MILP-CG	-	10 SM -100 Pa
2018	siu	Siu et al. (2018)	MILP, GA	-	16 SM - 90 Pa
2018	tohidifard	Tohidifard et al. (2018)	MILP- GA-PSO	-	25 SM - 175 Pa
2018	Xiao	Xiao et al. (2018)	MILP	-	15 SM- 23 V
2018	yang	Yang et al. (2018)	Best-Worst ACO	-	7 SM - 30 Pa - 60V
2018	zhang	Zhang et al. (2018)	mip, modified ACO	-	8 SM-105 V
2019	alves	Alves et al. (2019b)	Tchebycheff method - Genetic algorithm	-	5 SM - 22 Pa
2019	alves	Alves et al. (2019a)	MILP	-	5SM - 15 Pa
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	MILP	-	-
Sum				8	
Percentage (%)				12.70	
Global Sum				31	
Global Percentage (%)				20.26	

V: Visits; **SM:** Staff member; **Pa:** Patients;
2S: 2 Stage; **ACO:** Ant Colony Optimisation **BP:** Branch & Price; **BPC:** Branch & Price & Cut; **CG:** Column Generation; **CP:** Constraints Programming; **DA:** Decomposition Approach; **FCCP:** Fuzzy Chance Constraint Programming; **(H)GA:** (Hybrid) Genetic Algorithm; **IAA:** Implementor Adversarial Approach; **ILS:** Iterated Local Search; **LNS:** Large Neighborhood Search; **LR:** Lagrangian Relaxation; **MILP:** Mixed Integer Linear Programming; **NSGAII:** Non-Dominated Sorting Genetic Algorithm 2 ; **PEA:** Parallel Evolutionary Algorithm; **PSO :** Particle Swarm Optimisation; **RVND:** Random Variable Neighborhood Descent; **SAA:** Sample Average Approximation; **SPR:** Stochastic Programming model with Recourse; **Sim:** Simulation; **TS:** Tabu Search; **VNS:** Variable Neighborhood Search

Table 6: Objective function (Journal papers)

			Costs					Preference									
			Route	Staff members (SM)				Patients (Pa)							Staff members (SM)		
Year	First Author	References	Min travel time/cost/distance	Min total visit duration/ working time	Min waiting time	Min overtime/overcosts	Others	Max preferred time slot	Max patient preferences	Max continuity of care	Min uncovered visitsMax nb visits	Min reassignement	Min TW violation		Balance workload	Other	Other
1997	begur	Begur et al. (1997)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2000	hindle	Hindle et al. (2000)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2006	bertels	Bertels and Fahle (2006)	√	√	-	-	-	-	√	-	-	-	√		-	-	-
2006	eveborn	Eveborn et al. (2006)	√	-	-	-	-	√	√	-	-	-	-		-	-	-
2007	akjiratikarl	Akjiratikarl et al. (2007)	√	-	-	-	-	-	-	-	√	-	-		-	-	-
2008	bredstrom	Bredström and Rönnqvist (2008)	√	-	-	-	-	-	√	-	-	-	-		-	-	-
2009	chahed	Chahed et al. (2009)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2009	hindle	Hindle et al. (2009)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2011	ben bachouch	Ben Bachouch et al. (2011)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2011	bennett	Bennett and Erera (2011)	-	-	-	-	-	-	-	-	√	-	-		-	-	-
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	√	-	√	-	-	-	√	-	-	-	-		-	-	-
2011	trautsamwieser	Trautsamwieser et al. (2011)	√	-	-	-	-	√	-	-	-	-	-		-	-	-
2012	an	An et al. (2012)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2012	nickel	Nickel et al. (2012)	√	-	-	√	-	-	-	√	√	-	-		-	-	-
2012	rasmussen	Rasmussen et al. (2012)	√	-	-	-	-	-	√	-	√	-	-		-	-	-
2012	shao	Shao et al. (2012)	√	-	-	-	-	-	-	-	-	-	-		√	-	-
2013	allaoua	Allaoua et al. (2013)	-	-	-	-	SM1	-	-	-	-	-	-		-	-	-
2013	bard	Bard et al. (2013)	√	-	-	√	SM2	-	-	-	-	-	-		-	-	-
2013	cappanera	Cappanera and Scutellà (2013)	-	-	-	-	-	-	-	√	-	-	-		-	-	-
2013	mutingi	Mutingi and Mbohwa (2013a)	√	-	-	-	-	-	-	-	-	-	√		-	-	-
2014	bard	Bard et al. (2014a)	√	-	-	√	SM2	-	-	-	-	-	-		-	-	-
2014	bard	Bard et al. (2014b)	√	-	-	√	-	-	-	-	-	-	-		-	-	-
2014	cappanera	Cappanera and Scutellà (2014)	-	-	-	-	-	-	-	-	-	-	-		√	-	-
2014	carello	Carello and Lanzarone (2014)	-	-	-	√	-	-	-	-	-	√	-		-	-	-
2014	di gaspero	Di Gaspero and Urli (2014)	√	-	-	√	-	-	-	-	√	-	-		-	-	-
2014	lanzarone	Lanzarone and Matta (2014)	-	-	-	√	-	-	-	-	-	-	-		√	-	-
2014	mankowska	Mankowska et al. (2014)	√	-	-	-	-	-	-	-	-	-	√		-	Pa1	-
2014	mutingi	Mutingi and Mbohwa (2014)	-	-	-	-	-	√	-	-	-	-	-		√	-	O4
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	-	√	-	-	-	-	-	-	-	-	-		-	-	-
2015	bowers	Bowers et al. (2015)	√	-	-	-	-	-	-	√	-	-	-		-	-	-
2015	fikar	Fikar and Hirsch (2015)	√	√	-	-	-	-	-	-	-	-	-		-	-	-
2015	hiermann	Hiermann et al. (2015)	√	√	-	-	-	-	-	-	-	-	√		-	-	-
2015	issaoui	Issaoui et al. (2015a)	√	-	-	-	-	-	√	-	√	-	-		-	-	-
2015	lieder	Lieder et al. (2015)	-	-	-	-	-	-	-	-	-	-	√		-	-	-
2015	maya duque	Maya Duque et al. (2015)	√	-	-	-	-	√	√	-	-	-	-		-	-	-
2015	misir	Mısır et al. (2015)	√	-	-	√	-	-	-	-	-	-	√		√	-	-
2015	rodriguez	Rodriguez et al. (2015)	√	-	-	-	-	-	-	-	-	-	-		√	-	-
2015	yuan	Yuan et al. (2015)	√	√	-	-	-	-	-	-	-	-	-		-	-	-
2016	ait haddadene	Ait Haddadene et al. (2016a)	√	-	-	-	-	-	√	-	-	-	-		-	-	-
2016	braekers	Braekers et al. (2016)	√	-	-	√	-	√	√	-	-	-	-		-	-	-
2016	fikar	Fikar et al. (2016)	√	-	√	-	-	-	-	-	-	-	-		-	-	-
2016	heching	Heching and Hooker (2016)	√	-	√	-	-	-	-	-	√	-	-		-	-	-
2016	lin	Lin et al. (2016)	√	-	-	-	-	-	-	-	-	√	-		-	-	-
2016	redjem	Redjem and Marcon (2016)	√	-	√	-	-	-	-	-	-	-	-		-	-	-
2016	rest	Rest and Hirsch (2016)	√	-	√	√	-	-	-	-	-	-	-		-	SM3	-
2016	wirnitzer	Wirnitzer et al. (2016)	-	-	-	-	-	-	-	√	-	-	-		-	-	-
2016	yalcindag	Yalçındag et al. (2016b)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2016	yalcindag	Yalçındag et al. (2016a)	√	-	-	-	-	-	-	-	-	-	-		√	-	-
2017	cappanera	Cappanera et al. (2017)	-	-	-	-	-	-	-	-	-	-	-		√	-	-
2017	du	Du et al. (2017b)	-	-	-	-	-	-	√	-	-	-	-		-	-	O1
2017	du	Du et al. (2017a)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2017	erdem	Erdem and Bulkan (2017)	√	-	-	√	-	√	-	-	√	-	-		-	-	-
2017	frifita	Frifita et al. (2017)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2017	guericke	Guericke and Suhl (2017)	√	-	√	-	-	-	-	-	-	-	-		-	-	-
2017	liu	Liu et al. (2017)	√	-	-	-	-	-	-	-	√	-	-		-	-	-
2017	luna	Luna et al. (2017)	-	√	-	-	SM1	-	-	-	-	-	-		-	-	-
2017	marcon	Marcon et al. (2017)	√	-	√	-	-	-	-	-	-	-	-		-	-	-
2017	quintana	Quintana et al. (2017)	√	-	√	-	-	-	-	-	-	-	-		-	-	O2
2017	shi	Shi et al. (2017c)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2017	yuan	Yuan and Jiang (2017)	√	-	-	-	-	-	-	-	-	√	-		-	-	-
2018	carello	Carello et al. (2018)	-	-	-	√	-	-	-	√	-	√	-		√	-	-
2018	decerle	Decerle et al. (2018b)	√	-	-	-	-	-	-	-	-	-	√		-	-	-
2018	demirbilek	Demirbilek et al. (2018)	-	-	-	-	-	-	-	-	√	-	-		-	-	-
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	√	-	-	-	-	-	-	-	-	-	-		-	-	O3
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2018	fikar	Fikar and Hirsch (2018)	√	-	√	-	-	-	-	-	-	-	-		-	-	-
2018	lin	Lin et al. (2018)	√	-	-	√	-	-	-	-	-	-	-		-	-	-
2018	liu	Liu et al. (2018)	√	-	-	√	C1	-	-	-	-	-	-		-	Pa2	-
2018	mosquera	Mosquera et al. (2018)	√	-	-	-	-	-	√	√	√	-	-		-	-	-
2018	nasir	Nasir and Dang (2018)	√	-	-	√	-	-	√	-	-	-	-		√	-	-
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2018	szander	Szander et al. (2018b)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2018	szander	Szander et al. (2018a)	√	-	-	-	-	-	√	-	-	-	-		-	-	-
2018	yuan	Yuan et al. (2018)	√	-	-	-	-	-	-	-	√	-	-		-	-	-
2018	zhan	Zhan and Wan (2018)	√	-	√	√	C2	-	-	-	-	-	-		-	-	-
2019	chaieb	Chaieb et al. (2019)	√	-	√	-	-	-	-	-	√	-	-		√	-	-
2019	decerle	Decerle et al. (2019a)	√	-	-	-	-	-	-	-	-	-	√		√	-	-
2019	decerle	Decerle et al. (2019b)	-	√	-	-	-	-	-	-	-	-	√		√	-	-
2019	dekhici	Dekhici et al. (2019)	√	-	-	√	-	-	-	-	-	-	-		√	-	-
2019	demirbilek	Demirbilek et al. (2019)	-	-	-	-	-	-	-	-	√	-	-		-	-	-
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2019	gomes	Gomes and Ramos (2019)	√	-	-	-	-	-	-	-	-	-	-		√	-	-
2019	grenouilleau	Grenouilleau et al. (2019)	√	√	√	√	-	-	√	√	√	-	-		-	-	-
2019	heching	Heching et al. (2019)	-	-	-	-	-	-	-	-	√	-	-		-	-	-
2019	liu	Liu et al. (2019a)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2019	liu	Liu et al. (2019b)	√	-	-	-	-	-	-	-	√	-	-		-	-	-
2019	moussavi	Moussavi et al. (2019)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
2019	nasir	Nasir and Dang (2019)	√	-	-	-	C2, Pa10	-	-	-	-	-	-		-	-	-
2019	restrepo	Restrepo et al. (2019)	-	-	-	-	C2	-	-	-	-	-	-		-	-	-
2019	riazi	Riazi et al. (2019)	√	-	-	-	-	-	-	-	-	-	-		-	-	-
Sum			71	8	12	18	8	6	14	7	17	4	9		15	3	4
Percentage (%)			78.89	8.89	13.33	20.00	8.89	6.67	15.56	7.78	18.89	4.44	10.00		16.67	3.33	4.44
SubSum			71	35			4	45							16	0	4
Sub Percentage (%)			78.89	38.89			4.44	50.00							17.78	0	4.44
TOTAL SUM and %			COST: 79 (87.78%)					PREFERENCE: 54 (60.00%)									OTHER: 4 (4.4%)

see Table 7 for abbreviation meanings

Table 7: Objective function (Conference papers)

			Costs						Preference						
			Route		Staff members (SM)				Patients (Pa)				Staff members (SM)		
Year	First Author	References	Min travel time/cost/distance	Max benefices	Min total visit duration/ working time	Min waiting time	Min overtime/overcosts	Other	Max patient preferences	Max continuity of care	Min uncovered visits / Max nb visits	Min TW violation	Balance workload	Max clustering efficiency	Other
2006	borsani	Borsani et al. (2006)	-	-	-	-	-	-	-	√	-	-	-	√	Pa4
2008	elbenani	Elbenani et al. (2008)	√	-	-	-	-	-	-	-	-	-	-	-	-
2009	kergosien	Kergosien et al. (2009)	√	-	-	-	-	-	-	-	-	-	-	-	-
2010	misir	Mısır et al. (2010)	√	-	-	-	-	-	-	-	-	√	-	-	-
2011	redjem	Redjem et al. (2011)	√	-	-	√	-	-	-	-	-	-	-	-	-
2012	gamst	Gamst and Jensen (2012)	√	-	-	-	-	-	-	√	-	√	-	√	-
2013	errarhout	Errarhout et al. (2013)	-	-	-	-	-	-	-	-	-	-	√	-	-
2013	gayraud	Gayraud et al. (2013)	√	-	-	-	-	SM1	-	-	-	-	-	-	-
2013	jemai	Jemai et al. (2013)	√	-	-	-	-	-	-	-	-	-	-	-	-
2013	luna	Luna et al. (2013)	√	-	-	-	-	-	-	-	-	-	√	-	-
2014	cappanera	Cappanera et al. (2014)	√	-	-	-	-	-	-	-	-	-	√	-	-
2014	di mascolo	Di Mascolo et al. (2014)	-	-	-	√	-	-	-	-	-	-	-	-	-
2014	espinouse	Espinouse et al. (2014)	-	-	-	-	-	-	√	-	-	-	-	-	-
2014	kergosien	Kergosien et al. (2014)	√	-	-	-	-	SM5	-	-	-	√	-	-	Pa7
2014	labadie	Labadie et al. (2014)	√	-	-	-	-	-	√	-	-	-	-	-	-
2014	masmoudi	Masmoudi and Mellouli (2014)	√	-	-	-	-	-	-	-	-	-	-	-	-
2014	riazi	Riazi et al. (2014)	√	-	-	-	-	-	-	-	-	-	-	-	-
2014	yuan	Yuan et al. (2014)	√	-	-	-	-	-	-	-	-	-	-	-	Pa3
2015	aiane	Aiane et al. (2015)	√	-	-	-	-	-	-	-	-	-	-	-	-
2015	cattafi	Cattafi et al. (2015)	-	-	√	-	-	-	-	√	-	-	√	-	-
2015	en-nahli	En-nahli et al. (2015)	√	-	-	√	-	-	√	-	-	-	√	-	-
2015	laesanklang	Laesanklang et al. (2015)	√	-	√	-	-	SM6	√	-	-	√	-	√	Pa9
2015	rest	Rest and Hirsch (2015)	√	-	-	√	-	-	√	-	-	-	-	-	-
2015	xie	Xie and Wang (2015)	-	-	-	-	√	-	-	-	-	-	-	-	-
2016	ait haddadene	Ait Haddadene et al. (2016b)	√	-	-	-	-	-	√	-	-	-	-	-	-
2016	decerle	Decerle et al. (2016)	√	-	√	-	-	SM6	-	-	-	-	-	-	-
2016	en-nahli	En-nahli et al. (2016)	√	-	-	-	-	-	√	-	-	-	-	-	-
2016	manerba	Manerba and Mansini (2016)	-	√	-	-	-	-	-	-	-	-	-	-	-
2016	nguyen	Nguyen and Montemanni (2016)	√	-	-	-	√	-	√	-	-	-	-	-	-
2017	alves	Alves et al. (2017)	-	-	√	-	-	-	-	-	-	-	-	-	-
2017	baumann	Baumann (2017)	√	-	-	√	-	-	-	-	-	-	-	-	Pa4
2017	carello	Carello et al. (2017)	-	-	-	-	√	-	-	-	-	-	-	-	Pa8
2017	chen	Chen et al. (2017)	-	√	-	-	-	-	-	√	-	-	-	-	-
2017	decerle	Decerle et al. (2017)	-	-	√	-	-	-	-	-	-	-	√	-	-
2017	di mascolo	Di Mascolo et al. (2017b)	√	-	-	-	-	-	-	√	-	-	√	-	-
2017	el hajri	El Hajri et al. (2017)	-	-	√	-	-	-	-	√	-	-	√	-	-
2017	gunawan	Gunawan et al. (2017)	-	√	-	-	-	-	-	√	-	-	-	-	-
2017	lahrichi	Lahrichi et al. (2017)	√	-	√	-	-	-	-	-	-	-	-	-	-
2017	naji	Naji et al. (2017)	-	-	√	-	-	-	-	-	-	-	-	-	-
2017	shi	Shi et al. (2017a)	√	-	-	-	-	-	-	-	-	-	-	-	-
2017	shi	Shi et al. (2017b)	√	-	-	-	√	-	-	-	-	-	-	-	-
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	√	-	-	-	√	-	-	-	-	√	-	-	-
2017	xie	Xie and Wang (2017)	√	-	-	-	-	-	-	-	-	-	-	-	-
2017	yalcindag	Yalçındağ and Matta (2017)	-	-	-	-	-	-	-	-	-	-	√	-	SM4
2018	alves	Alves et al. (2018b)	-	-	√	-	-	-	-	-	-	-	-	-	-
2018	alves	Alves et al. (2018a)	√	-	-	-	-	-	-	-	-	-	-	-	-
2018	decerle	Decerle et al. (2018c)	√	-	-	-	-	SM6	-	-	-	√	-	-	Pa6
2018	decerle	Decerle et al. (2018a)	√	-	-	-	-	-	-	-	-	√	√	-	Pa6
2018	di mascolo	Di Mascolo et al. (2018)	-	-	-	-	-	-	√	-	-	√	-	-	-
2018	eliseu	Eliseu et al. (2018)	√	-	-	-	-	-	-	-	-	-	-	-	-
2018	feng	Feng and Wang (2018)	√	-	-	-	-	-	-	-	-	-	-	-	Pa11
2018	garaix	Garaix et al. (2018)	√	-	-	-	-	SM6, SM7	√	-	-	√	-	-	Pa6, Pa10
2018	martinez	Martinez et al. (2018)	√	-	-	√	-	-	-	√	-	-	-	-	-
2018	riazi	Riazi et al. (2018)	√	-		-	-	-	-	-	-	-	-	-	-
2018	siu	Siu et al. (2018)	√	-	√	-	-	-	-	-	-	-	-	-	-
2018	tohidifard	Tohidifard et al. (2018)	√	-	-	-	-	-	-	-	-	-	-	-	-
2018	Xiao	Xiao et al. (2018)	√	-	√	-	-	SM5	-	-	-	-	-	-	Pa6
2018	yang	Yang et al. (2018)	-	-	-	√	-	-	-	-	-	-	-	-	-
2018	zhang	Zhang et al. (2018)	√	-	√	√	-	-	-	-	-	-	-	-	-
2019	alves	Alves et al. (2019b)	√	-	√	-	-	-	-	-	-	-	-	-	-
2019	alves	Alves et al. (2019a)	√	-	-	-	-	-	-	-	-	-	-	-	-
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	√	-	-	-	-	-	-	-	-	√	-	-	Pa10
Sum			45	3	13	8	5	7	10	8	0	10	11	3	13
Percentage			71.4	4.76	21	12.7	7.937	11.1	15.9	12.7	0	15.9	17.5	4.76	20.6
Sub-Sum			48		29			0	29				14		0
Sub-Percentage			76.19		46.03			0	46.03				22.22		0
TOTAL SUM and %			COST: 58 (92.06%)						PREFERENCES: 35 (55.56%)						
Global Sum			116	3	21	20	23	15	24	15	17	19	26	4	42
Global Percentage			75.82	1.96	13.73	13.07	15.03	9.80	15.69	9.80	11.11	12.42	16.99	2.61	27.45
Global Sub-Sum			119		64			15	74				30		0
Global Sub-Percentage			77.27		41.56			9,74	48.05				19.48		0
TOTAL SUM and %			COST: 137 (89.54%)						PREFERENCES: 89 (58.17%)						

Pa1: max fairness among patients; **Pa2:** max patient preference; **Pa3:** min earliest arrival; **Pa4:** max preferred time slot; **Pa5:** max continuity of care; **Pa6:** min penalties of shared-visits non satisfied; **Pa7:** max number of demands; **Pa8:** min reassignment; **Pa9:** min skill level; **SM1:** min number of staff members; **SM2:** min reimbursed km; **SM3:** min overqualification; **SM4:** min the number of visits per staff member; **SM5:** min subcontracting cost; **SM6:** min payment for worker to perform a task; **O1:** min response time to disruptions; **O2:** min total number of clusters; **O3:** min environmental pollution; **O4:** max clustering efficiency **C1:** min therapy cost; **C2:** min labor cost (fixed cost of assigning a visit team);

Table 8: Constraints related to visits (Journal papers)

Year	First author	References	Visits								
			Characteristics(Ch)		Schedule (Sc)			Dependency (De)			
			Hard time window (TW)	Qualification required	Multiple visits per period	Visit frequency	Visit patterns	Disjunction	Synchronization	Precedence	Others
1997	begur	Begur et al. (1997)	√	√	-	-	-	-	-	-	-
2000	hindle	Hindle et al. (2000)	-	-	-	-	-	-	-	-	-
2006	bertels	Bertels and Fahle (2006)	√	√	-	-	-	-	-	-	-
2006	eveborn	Eveborn et al. (2006)	√	√	-	-	-	-	-	-	-
2007	akjiratikarl	Akjiratikarl et al. (2007)	√	-	-	-	-	-	-	-	-
2008	bredstrom	Bredström and Rönnqvist (2008)	√	-	-	-	-	-	√	-	-
2009	chahed	Chahed et al. (2009)	√	-	-	-	-	-	-	-	TW1
2009	hindle	Hindle et al. (2009)	-	-	-	-	-	-	-	-	-
2011	ben bachouch	Ben Bachouch et al. (2011)	√	√	-	-	-	-	√	-	-
2011	bennett	Bennett and Erera (2011)	√	-	-	√	√	-	-	-	-
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	√	√	-	-	-	-	-	-	-
2011	trautsamwieser	Trautsamwieser et al. (2011)	√	√	-	√	-	-	-	-	-
2012	an	An et al. (2012)	√	-	-	-	-	-	-	-	-
2012	nickel	Nickel et al. (2012)	√	√	-	√	√	-	-	-	-
2012	rasmussen	Rasmussen et al. (2012)	√	-	-	-	-	-	-	Min	-
2012	shao	Shao et al. (2012)	√	√	-	-	-	-	-	-	Ch1
2013	allaoua	Allaoua et al. (2013)	√	√	-	√	√	-	-	-	-
2013	bard	Bard et al. (2013)	-	√	-	-	-	-	-	-	-
2013	cappanera	Cappanera and Scutellà (2013)	-	√	-	√	√	-	-	-	-
2013	mutingi	Mutingi and Mbohwa (2013a)	-	-	-	-	-	-	-	-	-
2014	bard	Bard et al. (2014a)	-	√	-	-	-	-	-	-	-
2014	bard	Bard et al. (2014b)	√	-	-	-	√	-	-	Min	-
2014	cappanera	Cappanera and Scutellà (2014)	√	√	-	-	√	-	√	-	-
2014	carello	Carello and Lanzarone (2014)	-	-	-	-	-	-	-	-	-
2014	di gaspero	Di Gaspero and Urli (2014)	√	√	-	-	√	-	-	-	-
2014	lanzarone	Lanzarone and Matta (2014)	-	-	-	-	-	-	-	-	-
2014	mankowska	Mankowska et al. (2014)	√	√	-	-	-	-	√	Min	-
2014	mutingi	Mutingi and Mbohwa (2014)	√	√	-	-	-	-	√	-	-
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	√	√	-	-	-	-	-	-	-
2015	bowers	Bowers et al. (2015)	-	-	-	-	-	-	-	-	-
2015	fikar	Fikar and Hirsch (2015)	√	√	-	-	-	-	-	-	-
2015	hiermann	Hiermann et al. (2015)	√	√	-	-	-	-	-	-	-
2015	issaoui	Issaoui et al. (2015a)	√	√	-	-	-	-	-	-	-
2015	lieder	Lieder et al. (2015)	√	√	-	-	-	-	-	-	-
2015	maya duque	Maya Duque et al. (2015)	-	-	-	√	√	-	-	-	Sc1
2015	misir	Mısır et al. (2015)	-	√	-	-	-	-	-	-	-
2015	rodriguez	Rodriguez et al. (2015)	-	-	-	-	-	-	-	-	-
2015	yuan	Yuan et al. (2015)	-	√	-	-	-	-	-	-	-
2016	ait haddadene	Ait Haddadene et al. (2016a)	√	√	-	-	-	-	√	Exact	-
2016	braekers	Braekers et al. (2016)	√	√	-	-	-	-	-	-	-
2016	fikar	Fikar et al. (2016)	√	√	-	-	-	-	-	-	-
2016	heching	Heching and Hooker (2016)	√	-	-	√	-	-	-	-	-
2016	lin	Lin et al. (2016)	-	√	-	-	-	√	-	-	-
2016	redjem	Redjem and Marcon (2016)	√	-	√	-	-	√	-	Min	
2016	rest	Rest and Hirsch (2016)	√	√	-	-	-	-	-	-	-
2016	wirnitzer	Wirnitzer et al. (2016)	-	√	-	√	-	-	-	-	-
2016	yalcindag	Yalçındag et al. (2016b)	√	√	-	-	-	-	-	-	-
2016	yalcindag	Yalçındag et al. (2016a)	-	√	-	√	√	-	-	-	-
2017	cappanera	Cappanera et al. (2017)	-	√	-	-	√	-	-	-	-
2017	du	Du et al. (2017b)	√	-	-	-	-	-	-	-	-
2017	du	Du et al. (2017a)	√	-	-	-	-	-	-	-	-
2017	erdem	Erdem and Bulkan (2017)	√	√	-	-	-	-	√	-	-
2017	frifita	Frifita et al. (2017)	√	-	√	-	-	-	√	-	-
2017	guericke	Guericke and Suhl (2017)	√	√	-	-	-	-	-	-	-
2017	liu	Liu et al. (2017)	√	√	-	-	-	-	-	-	-
2017	luna	Luna et al. (2017)	√	-	-	-	-	-	-	-	-
2017	marcon	Marcon et al. (2017)	√	-	√	-	-	√	-	-	-
2017	quintana	Quintana et al. (2017)	-	-	-	-	-	-	-	-	-
2017	shi	Shi et al. (2017c)	√	-	-	-	-	-	-	-	-
2017	yuan	Yuan and Jiang (2017)	-	√	-	-	√	-	-	-	-
2018	carello	Carello et al. (2018)	√	√	-	-	-	-	-	-	-
2018	decerle	Decerle et al. (2018b)	-	√	-	-	-	-	√	-	-
2018	demirbilek	Demirbilek et al. (2018)	-	-	√	√	√	-	-	-	TW3
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	√	-	-	-	-	-	-	-	O1
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	√	-	-	-	-	-	-	-	-
2018	fikar	Fikar and Hirsch (2018)	√	√	-	-	-	-	-	-	-
2018	lin	Lin et al. (2018)	√	√	-	-	-	-	-	-	-
2018	liu	Liu et al. (2018)	-	√	-	√	-	-	-	-	O2
2018	mosquera	Mosquera et al. (2018)	√	-	√	√	-	-	-	-	-
2018	nasir	Nasir and Dang (2018)	√	√	-	-	-	-	-	-	-
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	√	√	-	-	-	-	√	-	-
2018	szander	Szander et al. (2018b)	√	-	-	-	-	-	-	-	-
2018	szander	Szander et al. (2018a)	-	-	-	√	-	-	-	-	-
2018	yuan	Yuan et al. (2018)	√	-	-	-	-	-	-	-	-
2018	zhan	Zhan and Wan (2018)	-	-	-	-	-	-	-	-	TW2
2019	chaieb	Chaieb et al. (2019)	√	√	-	-	-	-	-	√	-
2019	decerle	Decerle et al. (2019a)	√	√	-	-	-	-	√	-	-
2019	decerle	Decerle et al. (2019b)	√	√	-	-	-	-	√	-	-
2019	dekhici	Dekhici et al. (2019)	-	-	√	-	-	-	√	-	-
2019	demirbilek	Demirbilek et al. (2019)	-	√	√	√	√	-	-	-	-
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	√	-	-	-	-	-	-	-	-
2019	gomes	Gomes and Ramos (2019)	√	-	√	-	-	-	-	-	-
2019	grenouilleau	Grenouilleau et al. (2019)	√	√	-	-	-	-	-	-	-
2019	heching	Heching et al. (2019)	√	√	-	√	√	-	-	-	-
2019	liu	Liu et al. (2019a)	√	-	√	-	-	-	√	-	-
2019	liu	Liu et al. (2019b)	-	√	-	-	-	-	-	-	-
2019	moussavi	Moussavi et al. (2019)	-	-	√	-	-	-	-	-	TW2
2019	nasir	Nasir and Dang (2019)	√	√	-	-	-	-	-	-	-
2019	restrepo	Restrepo et al. (2019)	-	-	-	-	-	-	-	-	-
2019	riazi	Riazi et al. (2019)	-	√	-	-	-	-	-	-	-
Sum			60	52	10	15	14	3	14	6	8
Percentage (%)			66.67	57.78	11.11	16.67	15.56	3.33	15.56	6.67	8.99
SubSum			63	52			27			20	2
Sub Percentage (%)			70.00	57.78			30.00			22.22	2.25
TOTAL VISITS: sum - - (%)			81 - - (90.00)								

TW1: TW for production of drugs; **TW2:** appointment time/fixed visit; **TW3:** set of possible appointment times; **Sc1:** forbidden patterns; **CH1:** visit duration depends on qualification; **O1 :** each patient needs a specific drug; **O2:** required minimum visit length for patients

Table 9: Constraints related to visits (Conference papers)

			Visits								
			Characteristics (Ch)			Schedule (Sc)			Dependency (De)		
Year	First authors	References	Hard visit TW	qualification required	visit duration depends on qualification	Multiple visits per period	visit frequency	Visit patterns	Synchronization	Precedence	Others
2006	borsani	Borsani et al. (2006)	-	√	-	√	√	-	-	-	-
2008	elbenani	Elbenani et al. (2008)	√	-	-	-	-	-	-	-	TW1
2009	kergosien	Kergosien et al. (2009)	√	√	-	-	-	-	√	-	De1
2010	misir	Mısır et al. (2010)	-	√	-	-	-	-	-	-	-
2011	redjem	Redjem et al. (2011)	√	-	-	√	-	-	-	Min	-
2012	cattafi	Cattafi et al. (2012)	√	√	-	-	-	-	-	-	-
2012	gamst	Gamst and Jensen (2012)	-	√	-	-	-	-	-	-	-
2013	errarhout	Errarhout et al. (2013)	√	√	-	-	-	-	-	-	-
2013	gayraud	Gayraud et al. (2013)	√	√	√	-	-	-	-	-	
2013	jemai	Jemai et al. (2013)	√	√	-	-	-	-	-	-	-
2013	luna	Luna et al. (2013)	√	√	-	-	-	√	-	-	-
2014	cappanera	Cappanera et al. (2014)	-	√	-	-	-	√	-	-	-
2014	di mascolo	Di Mascolo et al. (2014)	√	-	-	-	-	-	√	-	-
2014	espinouse	Espinouse et al. (2014)	√	√	-	-	-	-	√	Exact	De1
2014	kergosien	Kergosien et al. (2014)	√	√	-	-	√	-	-	Exact	-
2014	labadie	Labadie et al. (2014)	√	√	-	-	-	-	√	-	-
2014	masmoudi	Masmoudi and Mellouli (2014)	√	-	-	-	-	-	√	-	-
2014	riazi	Riazi et al. (2014)	√	√	-	-	-	-	-	-	-
2014	yuan	Yuan et al. (2014)	-	-	-	-	-	-	-	-	-
2015	aiane	Aiane et al. (2015)	√	-	-	-	-	-	-	-	-
2015	cattafi	Cattafi et al. (2015)	√	-	-	-	√	-	-	-	-
2015	en-nahli	En-nahli et al. (2015)	√	√	-	-	-	-	-	-	-
2015	laesanklang	Laesanklang et al. (2015)	√	√	-	-	-	-	-	-	-
2015	rest	Rest and Hirsch (2015)	√	√	-	√	-	-	-	-	-
2015	xie	Xie and Wang (2015)	√	-	-	-	-	-	-	-	-
2016	ait haddaene	Ait Haddadene et al. (2016b)	√	√	-	√	-	-	√	Max	-
2016	decerle	Decerle et al. (2016)	√	√	-	-	-	-	√	Max	-
2016	en-nahli	En-nahli et al. (2016)	√	-	-	-	-	-	√	-	-
2016	manerba	Manerba and Mansini (2016)	√	-	-	√	-	-	-	-	TW2
2016	nguyen	Nguyen and Montemanni (2016)	√	√	-	-	-	-	-	-	-
2017	alves	Alves et al. (2017)	-	√	-	√	-	-	-	-	-
2017	baumann	Baumann (2017)	-	√	-	-	-	-	-	-	-
2017	carello	Carello et al. (2017)	-	-	-	-	-	-	-	-	-
2017	chen	Chen et al. (2017)	√	√	-	-	-	√	-	-	-
2017	decerle	Decerle et al. (2017)	-	√	-	-	-	-	√	-	-
2017	di mascolo	Di Mascolo et al. (2017b)	-	√	-	-	-	-	-	-	De1
2017	el hajri	El Hajri et al. (2017)	√	-	-	-	-	-	-	-	-
2017	gunawan	Gunawan et al. (2017)	√	√	-	-	-	-	-	-	-
2017	lahrichi	Lahrichi et al. (2017)	-	-	-	-	-	√	-	-	-
2017	naji	Naji et al. (2017)	√	-	-	-	-	-	√	-	-
2017	shi	Shi et al. (2017a)	-	-	-	-	-	-	-	-	-
2017	shi	Shi et al. (2017b)	-	-	-	-	-	-	-	-	-
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	√	-	-	-	-	-	-	-	-
2017	xie	Xie and Wang (2017)	√	-	-	-	-	-	-	-	-
2017	yalcindag	Yalçındağ and Matta (2017)	√	-	-	-	-	√	-	-	-
2018	alves	Alves et al. (2018b)	-	-	-	-	-	-	-	-	-
2018	alves	Alves et al. (2018a)	-	-	-	-	-	-	-	-	-
2018	decerle	Decerle et al. (2018c)	-	√	-	√	-	-	√	-	O7
2018	decerle	Decerle et al. (2018a)	√	√	-	√	-	-	√	-	O7
2018	di mascolo	Di Mascolo et al. (2018)	√	√	-	√	-	-	√	√	De1
2018	eliseu	Eliseu et al. (2018)	√	-	-	√	-	-	-	-	-
2018	feng	Feng and Wang (2018)	√	-	-	-	-	-	-	-	-
2018	garaix	Garaix et al. (2018)	√	√	-	√	-	-	√	-	-
2018	martinez	Martinez et al. (2018)	√	√	-	√	-	-	-	-	-
2018	riazi	Riazi et al. (2018)	√	√	-	-	-	-	-	-	-
2018	siu	Siu et al. (2018)	-	-	-	-	-	-	-	-	TW3
2018	tohidifard	Tohidifard et al. (2018)	√	√	-	-	-	-	-	-	O7
2018	Xiao	Xiao et al. (2018)	√	√	-	-	-	-	√	-	-
2018	yang	Yang et al. (2018)	-	√	√	√	-	-	-	-	-
2018	zhang	Zhang et al. (2018)	-	√	√	-	-	-	-	-	-
2019	alves	Alves et al. (2019b)	-	-	-	√	-	-	-	-	-
2019	alves	Alves et al. (2019a)	-	-	-	-	-	√	-	-	-
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	-	-	-	-	-	√	-	-	-
Sum			41	36	3	14	3	7	15	6	10
Percentage (%)			65.08	57.14	4.76	22.22	4.76	11.11	23.81	9.52	16.13
SubSum			42	36		23			18		3
Sub Percentage (%)			66.67	57.14		36.51			28.57		4.84
TOTAL VISITS: sum - - %			57 - - (91.94)								
Global Sum			101	88	4	24	18	21	29	12	21
Global Percentage (%)			66.01	57.52	2.61	15.69	11.76	13.73	18.95	7.84	13.73
Global Sub Sum			105	88		51			38		5
Global Sub Percentage (%)			68.63	57.52		33.33			24.84		3.27
GLOBAL VISITS: sum - - %			138 - - (90.20)								

TW1 : time window for producing drugs; TW2 : appointment time/fixed visit; TW3 : Max and Min Working Time; De1: Disjunction; O7: multiple home health care offices

Table 10: Constraints related to patients (Journal papers)

			Patient preference constraints			
			Continuity of care (CC)	Time (T)		
Year	First author	References	Same staff member	Soft TW	Prefered starting time	Other
1997	begur	Begur et al. (1997)	-	-	-	-
2000	hindle	Hindle et al. (2000)	-	-	-	-
2006	bertels	Bertels and Fahle (2006)	-	√	-	-
2006	eveborn	Eveborn et al. (2006)	-	-	√	-
2007	akjiratikarl	Akjiratikarl et al. (2007)	-	-	-	-
2008	bredstrom	Bredström and Rönnqvist (2008)	-	-	-	-
2009	chahed	Chahed et al. (2009)	-	-	-	-
2009	hindle	Hindle et al. (2009)	-	-	-	-
2011	ben bachouch	Ben Bachouch et al. (2011)	√	-	-	-
2011	bennett	Bennett and Erera (2011)	-	-	-	-
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	-	-	-	-
2011	trautsamwieser	Trautsamwieser et al. (2011)	-	√	-	-
2012	an	An et al. (2012)	-	-	-	T4
2012	nickel	Nickel et al. (2012)	√	-	-	-
2012	rasmussen	Rasmussen et al. (2012)	-	-	-	-
2012	shao	Shao et al. (2012)	-	-	-	-
2013	allaoua	Allaoua et al. (2013)	-	-	-	-
2013	bard	Bard et al. (2013)	-	-	-	-
2013	cappanera	Cappanera and Scutellà (2013)	-	-	-	-
2013	mutingi	Mutingi and Mbohwa (2013a)	-	√	-	-
2014	bard	Bard et al. (2014a)	-	-	-	-
2014	bard	Bard et al. (2014b)	-	-	-	-
2014	cappanera	Cappanera and Scutellà (2014)	√	-	-	-
2014	carello	Carello and Lanzarone (2014)	√	-	-	-
2014	di gaspero	Di Gaspero and Urli (2014)	-	-	-	T3
2014	lanzarone	Lanzarone and Matta (2014)	√	-	-	-
2014	mankowska	Mankowska et al. (2014)	-	√	-	-
2014	mutingi	Mutingi and Mbohwa (2014)	-	-	-	-
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	-	-	-	-
2015	bowers	Bowers et al. (2015)	√	-	-	-
2015	fikar	Fikar and Hirsch (2015)	-	-	-	-
2015	hiermann	Hiermann et al. (2015)	-	√	√	-
2015	issaoui	Issaoui et al. (2015a)	-	-	-	
2015	lieder	Lieder et al. (2015)	-	-	√	T2
2015	maya duque	Maya Duque et al. (2015)	√	-	√	CC1
2015	misir	Mısır et al. (2015)	-	√	-	-
2015	rodriguez	Rodriguez et al. (2015)	-	-	-	-
2015	yuan	Yuan et al. (2015)	-	-	-	-
2016	ait haddadene	Ait Haddadene et al. (2016a)	-	-	-	CC2
2016	braekers	Braekers et al. (2016)	-	-	√	CC2
2016	fikar	Fikar et al. (2016)	-	-	-	-
2016	heching	Heching and Hooker (2016)	√	-	-	T1
2016	lin	Lin et al. (2016)	√	√	√	-
2016	redjem	Redjem and Marcon (2016)	-	-	-	-
2016	rest	Rest and Hirsch (2016)	-	-	-	-
2016	wirnitzer	Wirnitzer et al. (2016)	√	-	-	-
2016	yalcindag	Yalçındag et al. (2016b)	-	-	-	-
2016	yalcindag	Yalçındag et al. (2016a)	√	-	-	-
2017	cappanera	Cappanera et al. (2017)	√	-	-	-
2017	du	Du et al. (2017b)	-	-	-	-
2017	du	Du et al. (2017a)	-	-	√	-
2017	erdem	Erdem and Bulkan (2017)	-	-	√	-
2017	frifita	Frifita et al. (2017)	-	-	-	-
2017	guericke	Guericke and Suhl (2017)	-	-	-	-
2017	liu	Liu et al. (2017)	√	-	-	-
2017	luna	Luna et al. (2017)	√	-	-	-
2017	marcon	Marcon et al. (2017)	-	-	-	-
2017	quintana	Quintana et al. (2017)	√	-	-	-
2017	shi	Shi et al. (2017c)	-	-	-	-
2017	yuan	Yuan and Jiang (2017)	√	√	-	-
2018	carello	Carello et al. (2018)	√	-	-	-
2018	decerle	Decerle et al. (2018b)	-	√	-	-
2018	demirbilek	Demirbilek et al. (2018)	√	-	-	CC1
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	-	-	-	-
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	-	-	-	-
2018	fikar	Fikar and Hirsch (2018)	-	-	-	-
2018	lin	Lin et al. (2018)	-	-	-	-
2018	liu	Liu et al. (2018)	√	-	-	-
2018	mosquera	Mosquera et al. (2018)	√	-	-	-
2018	nasir	Nasir and Dang (2018)	-	-	-	-
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	-	-	-	-
2018	szander	Szander et al. (2018b)	-	-	-	-
2018	szander	Szander et al. (2018a)	-	-	-	-
2018	yuan	Yuan et al. (2018)	-	-	-	-
2018	zhan	Zhan and Wan (2018)	-	-	-	-
2019	chaieb	Chaieb et al. (2019)	√	-	-	CC2
2019	decerle	Decerle et al. (2019a)	-	√	-	-
2019	decerle	Decerle et al. (2019b)	-	√	-	-
2019	dekhici	Dekhici et al. (2019)	-	√	-	-
2019	demirbilek	Demirbilek et al. (2019)	√	-	-	CC1
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	-	-	-	-
2019	gomes	Gomes and Ramos (2019)	-	-	-	CC3
2019	grenouilleau	Grenouilleau et al. (2019)	-	-	-	-
2019	heching	Heching et al. (2019)	-	-	-	-
2019	liu	Liu et al. (2019a)	-	-	-	-
2019	liu	Liu et al. (2019b)	-	√	-	-
2019	moussavi	Moussavi et al. (2019)	-	-	-	-
2019	nasir	Nasir and Dang (2019)	-	-	-	-
2019	restrepo	Restrepo et al. (2019)	-	-	-	-
2019	riazi	Riazi et al. (2019)	-	-	-	T4
Sum			22	13	8	13
Percentage (%)			24.44	14.44	8.89	14.61
SubSum			25	23		0
Sub Percentage (%)			27.78	25.56		0
TOTAL PATIENTS: sum - - (%)			41 - - (45.55)			

CC1: same time slot; CC2: preferred staff member; CC3 : non loyalty T1: preferred day of visit; T2: earliest time; T3: latest time; T4: fixed care interval

Table 11: Constraints related to patients (Conference papers)

			Patients preference constraints				
			Continuity of care		Time		
Year	First authors	References	same staff member(s)	preferred staff member	Soft /Mixed TW	Preferred day/time of visits	Others
2006	borsani	Borsani et al. (2006)	√	-	-	√	-
2008	elbenani	Elbenani et al. (2008)	-	-	-	-	-
2009	kergosien	Kergosien et al. (2009)	-	-	-	-	CC4
2010	misir	Mısır et al. (2010)	-	-	-	-	CC1, T5
2011	redjem	Redjem et al. (2011)	-	-	-	-	-
2012	cattafi	Cattafi et al. (2012)	-	-	-	-	-
2012	gamst	Gamst and Jensen (2012)	-	-	√	-	-
2013	errarhout	Errarhout et al. (2013)	√	-	-	-	-
2013	gayraud	Gayraud et al. (2013)	-	-	-	-	-
2013	jemai	Jemai et al. (2013)	-	-	-	-	-
2013	luna	Luna et al. (2013)	-	-	-	-	-
2014	cappanera	Cappanera et al. (2014)	-	-	-	-	-
2014	di mascolo	Di Mascolo et al. (2014)	-	-	-	-	-
2014	espinouse	Espinouse et al. (2014)	-	-	-	-	-
2014	kergosien	Kergosien et al. (2014)	-	-	-	-	-
2014	labadie	Labadie et al. (2014)	-	-	-	-	-
2014	masmoudi	Masmoudi and Mellouli (2014)	-	-	-	-	-
2014	riazi	Riazi et al. (2014)	-	-	-	-	-
2014	yuan	Yuan et al. (2014)	-	-	-	-	T3
2015	aiane	Aiane et al. (2015)	-	-	-	-	-
2015	cattafi	Cattafi et al. (2015)	-	-	-	√	-
2015	en-nahli	En-nahli et al. (2015)	-	√	-	-	-
2015	laesanklang	Laesanklang et al. (2015)	-	-	-	-	-
2015	rest	Rest and Hirsch (2015)	-	-	-	√	-
2015	xie	Xie and Wang (2015)	-	-	-	-	-
2016	ait haddaene	Ait Haddadene et al. (2016b)	-	√	-	-	-
2016	decerle	Decerle et al. (2016)	-	-	-	-	-
2016	en-nahli	En-nahli et al. (2016)	-	-	-	-	-
2016	manerba	Manerba and Mansini (2016)	-	-	-	-	-
2016	nguyen	Nguyen and Montemanni (2016)	-	-	-	√	-
2017	alves	Alves et al. (2017)	-	-	-	-	-
2017	baumann	Baumann (2017)	√	-	-	-	-
2017	carello	Carello et al. (2017)	√	-	-	-	-
2017	chen	Chen et al. (2017)	√	-	-	-	-
2017	decerle	Decerle et al. (2017)	-	-	√	-	-
2017	di mascolo	Di Mascolo et al. (2017b)	√	-	-	-	-
2017	el hajri	El Hajri et al. (2017)	-	-	-	-	-
2017	gunawan	Gunawan et al. (2017)	-	-	-	-	-
2017	lahrichi	Lahrichi et al. (2017)	-	-	-	-	-
2017	naji	Naji et al. (2017)	-	-	-	-	-
2017	shi	Shi et al. (2017a)	-	-	-	-	-
2017	shi	Shi et al. (2017b)	-	-	-	-	-
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	-	-	-	-	-
2017	xie	Xie and Wang (2017)	-	-	-	-	-
2017	yalcindag	Yalçındağ and Matta (2017)	√	-	-	-	-
2018	alves	Alves et al. (2018b)	-	-	-	-	-
2018	alves	Alves et al. (2018a)	-	-	-	-	-
2018	decerle	Decerle et al. (2018c)	-	-	√	-	-
2018	decerle	Decerle et al. (2018a)	-	-	-	-	-
2018	di mascolo	Di Mascolo et al. (2018)	-	-	√	-	O8
2018	eliseu	Eliseu et al. (2018)	-	√	√	-	-
2018	feng	Feng and Wang (2018)	-	-	-	-	T5
2018	garaix	Garaix et al. (2018)	-	√	-	-	-
2018	martinez	Martinez et al. (2018)	√	-	-	-	-
2018	riazi	Riazi et al. (2018)	-	-	-	-	-
2018	siu	Siu et al. (2018)	√	-	-	-	T3
2018	tohidifard	Tohidifard et al. (2018)	-	-	-	-	-
2018	Xiao	Xiao et al. (2018)	-	√	-	-	-
2018	yang	Yang et al. (2018)	-	√	√	-	-
2018	zhang	Zhang et al. (2018)	-	-	√	-	-
2019	alves	Alves et al. (2019b)	√	-	-	-	-
2019	alves	Alves et al. (2019a)	√	-	-	-	-
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	-	-	-	√	-
Sum			11	6	7	5	6
Percentage (%)			17.46	9.52	11.11	7.94	9.52
SubSum			19		16		1
Sub Percentage (%)			30.16		25.40		1.59
TOTAL PATIENTS: sum - - (%)			30 - - (47.62)				

Global Sum	33	9	20	6	19
Global Percentage (%)	21.57	5.88	13.07	3.92	12.42
Global SubSum	44		39		1
Global Sub Percentage (%)	28.76		25.49		0.65
GLOBAL PATIENTS: sum- - (%)	71 - - (46.41)				

CC1: same time slot; **CC4:** pre-assigned staff member ; **T3:** latest time; **T5:** preferred starting time; **O8:** preferred staff member gender

Table 12: Constraints related to staff members (Journal papers)

			Staff Members' constraints									
			Characteristics (Ch)			Rules (R.)					Transport	
Year	First author	References	Skill level	Hard TW/ availability	Soft TW	Legislative rules : break lunch. max working time, Max working time before/after break	Limited number of visited patients	district / region	Incompatibility with patients	Mode	Others
1997	begur	Begur et al. (1997)	√	-	-	-	-	-	-	-	-
2000	hindle	Hindle et al. (2000)	-	√	-	-	-	-	-	-	-
2006	bertels	Bertels and Fahle (2006)	√	√	-	-	-	-	-	-	-
2006	eveborn	Eveborn et al. (2006)	√	√	-	√	-	√	-	-	-
2007	akjiratikarl	Akjiratikarl et al. (2007)	-	-	√	√	-	-	-	-	-
2008	bredstrom	Bredström and Rönnqvist (2008)	-	√	-	-	-	-	-	-	-
2009	chahed	Chahed et al. (2009)	-	-	-	-	-	-	-	-	-
2009	hindle	Hindle et al. (2009)	-	√	-	-	-	-	-	-	-
2011	ben bachouch	Ben Bachouch et al. (2011)	√	-	-	√	-	√	-	-	-
2011	bennett	Bennett and Erera (2011)	-	√	-	-	-	-	-	-	-
2011	trautsamwieser	Trautsamwieser and Hirsch (2011)	√	-	√	√	-	√	√	-	R1
2011	trautsamwieser	Trautsamwieser et al. (2011)	√	-	√	√	-	-	√	-	-
2012	an	An et al. (2012)	-	√	-	√	-	-	-	-	-
2012	nickel	Nickel et al. (2012)	√	√	-	-	-	-	-	-	-
2012	rasmussen	Rasmussen et al. (2012)	-	√	-	√	-	-	-	-	-
2012	shao	Shao et al. (2012)	√	√	-	-	-	-	-	-	-
2013	allaoua	Allaoua et al. (2013)	√	√	-	-	-	-	-	-	-
2013	bard	Bard et al. (2013)	√	√	-	√	-	-	-	-	-
2013	cappanera	Cappanera and Scutellà (2013)	√	-	-	-	-	-	-	-	-
2013	mutingi	Mutingi and Mbohwa (2013a)	-	√	-	-	-	-	-	-	-
2014	bard	Bard et al. (2014a)	√	-	-	√	-	-	-	-	-
2014	bard	Bard et al. (2014b)	-	-	√	√	-	-	-	-	-
2014	cappanera	Cappanera and Scutellà (2014)	-	√	-	-	-	-	-	-	-
2014	carello	Carello and Lanzarone (2014)	-	-	-	-	-	√	-	-	-
2014	di gaspero	Di Gaspero and Urli (2014)	√	-	-	-	-	-	√	-	-
2014	lanzarone	Lanzarone and Matta (2014)	-	-	-	√	-	-	-	-	-
2014	mankowska	Mankowska et al. (2014)	√	-	-	-	-	-	-	-	-
2014	mutingi	Mutingi and Mbohwa (2014)	√	√	-	-	-	-	-	-	-
2014	trautsamwieser	Trautsamwieser and Hirsch (2014)	√	√	-	√	-	-	-	-	-
2015	bowers	Bowers et al. (2015)	-	-	-	-	-	-	-	-	-
2015	fikar	Fikar and Hirsch (2015)	√	-	-	√	√	-	-	sharing vehicles, walk	R3, R4
2015	hiermann	Hiermann et al. (2015)	√	√	-	√	-	-	√	Public or car	R2
2015	issaoui	Issaoui et al. (2015a)	√	-	-	√	-	-	-	-	-
2015	lieder	Lieder et al. (2015)	√	-	-	-	-	-	-	-	-
2015	maya duque	Maya Duque et al. (2015)	-	-	-	√	-	-	-	-	-
2015	misir	Mısır et al. (2015)	√	√	-	-	-	-	-	-	-
2015	rodriguez	Rodriguez et al. (2015)	√	-	-	√	-	√	-	-	-
2015	yuan	Yuan et al. (2015)	√	-	-	-	√	-	-	-	-
2016	ait haddadene	Ait Haddadene et al. (2016a)	√	√	-	-	√	-	-	-	-
2016	braekers	Braekers et al. (2016)	√	-	-	√	-	-	-	public - car	-
2016	fikar	Fikar et al. (2016)	√	-	-	√	-	-	-	sharing vehicles, walk	R4
2016	heching	Heching and Hooker (2016)	-	√	-	-	-	-	-	-	-
2016	lin	Lin et al. (2016)	√	-	-	-	-	-	-	-	-
2016	redjem	Redjem and Marcon (2016)	-	√	-	-	-	-	-	-	-
2016	rest	Rest and Hirsch (2016)	√	√	-	√	-	-	√	public mode	-
2016	wirnitzer	Wirnitzer et al. (2016)	√	-	-	√	-	√	√	-	R2
2016	yalcindag	Yalçındag et al. (2016b)	√	√	-	-	-	-	-	-	-
2016	yalcindag	Yalçındag et al. (2016a)	√	-	-	√	-	-	-	-	-
2017	cappanera	Cappanera et al. (2017)	√	-	-	√	-	-	-	-	-
2017	du	Du et al. (2017b)	-	-	-	-	-	-	-	-	-
2017	du	Du et al. (2017a)	-	-	-	-	-	-	-	-	-
2017	erdem	Erdem and Bulkan (2017)	-	√	-	-	-	-	√	public-car	-
2017	frifita	Frifita et al. (2017)	-	-	-	-	-	-	-	-	-
2017	guericke	Guericke and Suhl (2017)	√	√	-	√	-	-	-	-	-
2017	liu	Liu et al. (2017)	√	√	-	√	-	-	-	-	-
2017	luna	Luna et al. (2017)	-	√	-	-	-	-	-	-	-
2017	marcon	Marcon et al. (2017)	-	-	-	-	-	-	-	-	-
2017	quintana	Quintana et al. (2017)	-	√	-	√	-	√	-	-	-
2017	shi	Shi et al. (2017c)	-	√	-	-	-	-	-	-	-
2017	yuan	Yuan and Jiang (2017)	-	-	-	-	-	-	-	-	-
2018	carello	Carello et al. (2018)	√	-	-	√	-	√	-	-	-
2018	decerle	Decerle et al. (2018b)	√	√	-	-	-	-	-	-	-
2018	demirbilek	Demirbilek et al. (2018)	-	-	-	-	-	-	-	-	-
2018	fathollahi-fard	Fathollahi-Fard et al. (2018a)	-	-	-	-	-	-	-	public-car-other	R6
2018	fathollahi-fard	Fathollahi-Fard et al. (2018b)	-	-	-	-	-	-	-	public-car-other	-
2018	fikar	Fikar and Hirsch (2018)	√	-	-	√	√	-	-	sharing vehicles, walk	R3, R4
2018	lin	Lin et al. (2018)	√	-	-	√	-	-	-	-	-
2018	liu	Liu et al. (2018)	√	-	-	√	-	-	-	-	R5
2018	mosquera	Mosquera et al. (2018)	-	√	-	-	√	-	√	-	-
2018	nasir	Nasir and Dang (2018)	√	√	-	√	-	-	-	-	-
2018	sinthamrongruk	Sinthamrongruk et al. (2018)	√	-	-	-	√	-	-	-	-
2018	szander	Szander et al. (2018b)	-	-	-	-	-	-	-	-	-
2018	szander	Szander et al. (2018a)	-	-	-	√	√	-	-	public-car	-
2018	yuan	Yuan et al. (2018)	-	-	-	-	-	-	-	-	-
2018	zhan	Zhan and Wan (2018)	-	-	-	-	-	-	-	-	-
2019	chaieb	Chaieb et al. (2019)	√	√	-	√	-	√	√	public - car	-
2019	decerle	Decerle et al. (2019a)	√	√	-	√	-	-	-	car	-
2019	decerle	Decerle et al. (2019b)	√	√	-	√	-	-	-	car	-
2019	dekhici	Dekhici et al. (2019)	-	√	-	-	-	-	-	-	-
2019	demirbilek	Demirbilek et al. (2019)	√	√	-	-	-	√	-	-	-
2019	fathollahi-fard	Fathollahi-Fard et al. (2019)	-	-	-	-	-	-	-	public - car	-
2019	gomes	Gomes and Ramos (2019)	-	-	-	√	-	-	-	-	-
2019	grenouilleau	Grenouilleau et al. (2019)	√	√	-	-	-	-	-	-	-
2019	heching	Heching et al. (2019)	√	√	-	√	-	-	-	-	-
2019	liu	Liu et al. (2019a)	-	√	-	√	-	-	-	-	-
2019	liu	Liu et al. (2019b)	√	-	-	-	-	-	-	-	-
2019	moussavi	Moussavi et al. (2019)	-	-	-	√	-	-	-	-	-
2019	nasir	Nasir and Dang (2019)	√	-	-	√	-	-	-	-	-
2019	restrepo	Restrepo et al. (2019)	-	-	-	√	-	√	-	-	-
2019	riazi	Riazi et al. (2019)	√	√	-	-	-	-	-	-	-
Sum			50	41	4	41	7	11	9	14	8
Percentage (%)			56.56	45.56	4.44	45.56	7.78	12.22	10.00	15.56	8.89
SubSum			50	45		46		11	9	14	0
Sub Percentage (%)			55.56	50.00		51.11		12.22	10.00	15.56	0
TOTAL STAFF MEMBERS sum - - (%)			77 - - (85.56)								

R1: soft time window break; **R2:** additional jobs : meeting, administrative, etc.; **R3:** maximum walking duration; **R4:** maximum number of downgrading allowed per nurse; **R5:** fixed working days for nurses; **R6:** limited traveling time for each nurse

Table 13: Constraints related to staff members (Conference papers)

			Staff Member constraints				
			Characteristics (Ch)		Rules (R)		
Year	First authors	References	Skill level	Hard staff member TW	Legislative rules : break lunch, max working time, max working time before/after break	district/region	Others
2006	borsani	Borsani et al. (2006)	√	-	√	√	-
2008	elbenani	Elbenani et al. (2008)	-	√	-	√	-
2009	kergosien	Kergosien et al. (2009)	√	√	√	-	-
2010	misir	Mısır et al. (2010)	√	-	-	-	-
2011	redjem	Redjem et al. (2011)	-	√	-	-	-
2012	cattafi	Cattafi et al. (2012)	√	√	-	-	-
2012	gamst	Gamst and Jensen (2012)	√	√	-	√	-
2013	errarhout	Errarhout et al. (2013)	√	-	√	√	-
2013	gayraud	Gayraud et al. (2013)	√	√	-	-	-
2013	jemai	Jemai et al. (2013)	√	√	-	√	-
2013	luna	Luna et al. (2013)	-	√	√	√	-
2014	cappanera	Cappanera et al. (2014)	-	-	-	-	-
2014	di mascolo	Di Mascolo et al. (2014)	-	√	-	-	-
2014	espinouse	Espinouse et al. (2014)	√	-	-	-	R7
2014	kergosien	Kergosien et al. (2014)	√	√	√	-	O9, O3
2014	labadie	Labadie et al. (2014)	√	√	-	-	-
2014	masmoudi	Masmoudi and Mellouli (2014)	-	-	-	-	-
2014	riazi	Riazi et al. (2014)	√	√	-	-	-
2014	yuan	Yuan et al. (2014)	-	√	-	-	-
2015	aiane	Aiane et al. (2015)	-	√	√	√	-
2015	cattafi	Cattafi et al. (2015)	√	√	-	-	-
2015	en-nahli	En-nahli et al. (2015)	√	-	√	-	-
2015	laesanklang	Laesanklang et al. (2015)	√	√	-	√	-
2015	rest	Rest and Hirsch (2015)	√	-	√	-	O4,Ch1
2015	xie	Xie and Wang (2015)	√	√	-	-	-
2016	ait haddaene	Ait Haddadene et al. (2016b)	√	√	-	-	-
2016	decerle	Decerle et al. (2016)	√	√	-	-	-
2016	en-nahli	En-nahli et al. (2016)	-	√	-	-	-
2016	manerba	Manerba and Mansini (2016)	-	-	√	-	-
2016	nguyen	Nguyen and Montemanni (2016)	√	-	√	-	Ch1
2017	alves	Alves et al. (2017)	√	-	-	-	-
2017	baumann	Baumann (2017)	-	√	√	-	-
2017	carello	Carello et al. (2017)	-	-	-	-	-
2017	chen	Chen et al. (2017)	√	√	-	-	-
2017	decerle	Decerle et al. (2017)	√	√	-	-	-
2017	di mascolo	Di Mascolo et al. (2017b)	√	√	√	-	-
2017	el hajri	El Hajri et al. (2017)	-	-	-	-	-
2017	gunawan	Gunawan et al. (2017)	√	√	√	-	-
2017	lahrichi	Lahrichi et al. (2017)	-	-	-	-	-
2017	naji	Naji et al. (2017)	-	-	-	-	-
2017	shi	Shi et al. (2017a)	-	-	-	-	O5
2017	shi	Shi et al. (2017b)	-	-	√	-	O5
2017	sinthamrongruk	Sinthamrongruk et al. (2017)	-	-	-	-	O4,R7
2017	xie	Xie and Wang (2017)	-	-	-	-	-
2017	yalcindag	Yalçındağ and Matta (2017)	-	-	-	-	-
2018	alves	Alves et al. (2018b)	-	-	-	-	-
2018	alves	Alves et al. (2018a)	-	-	-	-	-
2018	decerle	Decerle et al. (2018c)	√	√	-	-	-
2018	decerle	Decerle et al. (2018a)	-	√	-	-	-
2018	di mascolo	Di Mascolo et al. (2018)	√	√	-	-	-
2018	eliseu	Eliseu et al. (2018)	-	√	√	-	O6
2018	feng	Feng and Wang (2018)	-	-	-	-	-
2018	garaix	Garaix et al. (2018)	√	√	-	-	-
2018	martinez	Martinez et al. (2018)	√	√	√	-	O6
2018	riazi	Riazi et al. (2018)	√	√	-	-	-
2018	siu	Siu et al. (2018)	-	-	√	-	-
2018	tohidifard	Tohidifard et al. (2018)	√	-	-	-	O5
2018	Xiao	Xiao et al. (2018)	√	√	√	-	-
2018	yang	Yang et al. (2018)	√	-	-	-	-
2018	zhang	Zhang et al. (2018)	√	-	-	√	-
2019	alves	Alves et al. (2019b)	-	-	-	-	-
2019	alves	Alves et al. (2019a)	-	-	-	-	-
2019	espadinha	Espadinha and Cardoso-Grilo (2019)	-	-	-	-	-
Sum			34	33	18	9	10
Percentage (%)			53.97	52.38	28.57	14.29	15.87
SubSum			44		21		
Sub Percentage (%)			69.84		33.33		
TOTAL STAFF MEMBERS sum - - (%)			48 - - (76.19)				

Global Sum	84	89	59	20	18
Global Percentage (%)	54.90	58.17	38.56	13.07	11.76
SubSum	76.00		21.00		
Sub Percentage (%)	49.67		13.64		
TOTAL STAFF MEMBERS sum - - (%)	125 - - (81.70)				

R7 : limited number of patients visited per nurse; **O3:** stops at drop off points; **O4 :**transport mode personal car & walk; **O5 :** vehicle capacity; **O6 :** nurses in team of 7 or less, traveling in different vehicles; **O9:** maximum transport delay for some blood samples; **Ch1:** soft SM time window

Table 14: Uncertainties and dynamic changes

References			Uncertainties/Changes											Modeling											
			Demands			Patients			Staff			Other	Type	Variables			Model	Objective function							
Year	First author	References	travel times	visit time	new demands	new patients	cancellations / departure	change of availabilities	new staff member	cancellation	new availabilities			interval	random variables	scenarios		min travel/idle times	min costs/max reward	min working time/overtime	balance workloads	min deviation from original schedule	max number of patients covered	min late arrival (penalties)	others
2011	bennett	Bennett and Erera (2011)	-	-	-	√	-	-	-	-	-	-	dynamic	-	-	-	-	√	-	-	-	-	-	-	-
2012	nickel	Nickel et al. (2012)	-	-	-	√	√	-	-	-	√	-	stable	-	-	-	-	-	-	-	-	√	-	-	-
2014	*cappanera*	*Cappanera et al. (2014)*	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-	-	√	√	-	-	-	-	-
2014	carello	Carello and Lanzarone (2014)	-	√	-	-	-	-	-	-	-	-	robust	√	-	-	CaCM	-	-	√	-	-	-	-	-
2014	lanzarone	Lanzarone and Matta (2014)	-	√	-	√	-	-	-	-	-	-	stochastic	-	√	-	SP	-	-	√	-	-	-	-	-
2015	*rest*	*Rest and Hirsch (2015)*	√	√	√	√	-	-	-	√	-	-	dynamic	-	-	-	-	√	-	-	-	-	-	-	-
2015	rodriguez	Rodriguez et al. (2015)	-	√	√	-	-	-	-	-	-	-	stochastic	-	-	√	SP	-	√	-	-	-	-	-	-
2015	yuan	Yuan et al. (2015)	-	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	SMR	-	√	-	-	-	-	√	-
2016	fikar	Fikar et al. (2016)	-	-	√	-	√	-	-	-	-	-	dynamic	-	-	-	DE-meta	√	-	-	-	-	-	-	-
2016	heching	Heching and Hooker (2016)	-	-	-	√	-	-	-	-	-	-	dynamic	-	-	-	-	√	-	-	-	-	√	-	-
2016	*nguyen*	*Nguyen and Montemanni (2016)*	-	-	-	-	-	-	-	√	-	-	robust	-	-	-	-	-	√	-	-	-	-	-	-
2016	yalcindag	Yalçındag et al. (2016b)	√	-	-	-	-	-	-	-	-	-	-	-	-	-	kernel regression	√	-	-	√	-	-	-	-
2017	cappanera	Cappanera et al. (2017)	-	-	√	√	√	-	-	-	-	-	robust	-	-	-	CaCM	-	-	-	√	-	-	-	-
2017	*carello*	*Carello et al. (2017)*	-	√	-	-	-	-	-	-	-	-	robust	√	-	-	CaCM	-	-	√	-	-	-	-	O1
2017	*chen*	*Chen et al. (2017)*	√	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	ChCM	-	√	-	-	-	-	-	-
2017	*di mascolo*	*Di Mascolo et al. (2017b)*	-	-	-	-	-	-	-	√	-	-	dynamic-stable	-	-	-	-	√	-	-	√	-	-	-	O2
2017	du	Du et al. (2017b)	-	-	√	-	√	-	-	-	-	-	dynamic	-	-	-	-	-	-	-	-	-	-	-	O3
2017	*gunawan*	*Gunawan et al. (2017)*	-	-	-	-	√	-	-	-	-	-	stochastic	-	√	-	SP	-	√	-	-	-	-	-	-
2017	marcon	Marcon et al. (2017)	√	-	-	-	-	-	-	-	-	-	dynamic	-	-	-	recourse actions	√	-	-	-	-	-	-	-
2017	*naji*	*Naji et al. (2017)*	√	√	-	-	-	-	-	-	-	-	robust	-	-	√	worst-case MILP	-	-	√	-	-	-	-	-
2017	*shi*	*Shi et al. (2017b)*	√	√	-	-	-	-	-	-	-	-	stochastic-stable	-	√	-	SMR	-	-	-	-	-	-	√	-
2017	*xie*	*Xie and Wang (2017)*	-	-	√	-	√	-	-	√	√	-	dynamic	-	-	-	-	-	√	-	-	-	-	-	-
2017	yuan	Yuan and Jiang (2017)	-	-	√	-	√	√	-	-	-	-	stable	-	-	-	-	-	-	-	-	√	-	√	-
2018	alves	Alves et al. (2018a)	-	-	-	-	-	-	-	-	-	U1	dynamic	-	-	-	MaS	√						√	
2018	demirbilek	Demirbilek et al. (2018)	-	-	-	√	-	-	-	-	-	-	dynamic	-	-	√	SBA	-	-	-	-	-	√	-	
2018	lin	Lin et al. (2018)	-	-	-	-	√	√	-	√	-	-	stable	-	-	-	-	-	-	-	-	√	-	-	-
2018	mosquera	Mosquera et al. (2018)	-	√	-	-	-	-	-	-	-	U2	flexible	√	-	-	-	-	-	-	-	-	-	-	O4
2018	nasir	Nasir and Dang (2018)	-	-	-	√	-	-	√	-	-	-	flexible	-	-	-	-	-	√	-	-	-	-	-	-
2018	*yang*	*Yang et al. (2018)*	-	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	ChCM	√	-	-	-	-	-	-	-
2018	yuan	Yuan et al. (2018)	√	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	ChCM	-	√	-	-	-	-	-	-
2018	zhan	Zhan and Wan (2018)	-	√	-	-	-	-	-	-	-	-	stochastic	-	-	√	SBA	-	√	-	-	-	-	-	-
2018	*zhang*	*Zhang et al. (2018)*	-	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	-	√	√	√	-	-	-	-	-
2019	demirbilek	Demirbilek et al. (2019)	-	-	-	√	-	-	-	-	-	-	dynamic	-	-	√	SBA	-	-	-	-	-	√	-	-
2019	liu	Liu et al. (2019b)	√	√	-	-	-	-	-	-	-	-	stochastic	-	√	-	ChCM	-	√	-	-	-	-	√	-
2019	gomes	Gomes and Ramos (2019)	-	-	-	√	√	-	-	-	-	-	dynamic	-	-	-	-	√	-	-	√	√	-	-	-
2019	nasir	Nasir and Dang (2019)	-	-	-	√	-	-	√	-	-	-	flexible	-	-	-	-	-	√	-	-	-	-	-	-
2019	restrepo	Restrepo et al. (2019)	-	-	√	-	-	-	-	-	-	-	stochastic-flexible	-	-	√	SMR	-	√	-	-	-	-	-	O1
Sum			9	16	8	11	9	2	2	5	2			3	10	6		11	14	6	4	4	3	5	5
Percentage (%)			24.3	43.2	21.6	29.7	24.3	5.4	5.4	13.5	5.4			8.1	27.0	16.2		29.7	38.9	16.7	11.1	11.1	8.3	13.5	14.3

Conference papers are in italic.

CaCM: Cardinality constrained model; **ChCM:** Chance constrained model; **SBA:** Scenario based approach; **SMR :** Stochastic model with recourse; **SP:** Stochastic programming; **MaS:** Multi-agent Simulation; **DE-meta:** discrete event driven metaheuristic
U1: broken vehicle; **U2:** change of visit frequency; **O1:** Min reassignment costs; **O2:** Min nb tours impacted; **O3:** Min response time; **O4:** Min deviation from preferred time and frequency;

HIGHLIGHTS

- Synthesis of the literature dealing on routing and scheduling in HHC context
- Numerical analysis and classification of the papers
- Focus on the uncertain and dynamic aspects
- Discussions on current trends in HHC routing and scheduling
- Future research directions