Chapter 4
A Cluster First–Route Second Solution Approach for the Multi-Period Home Healthcare Routing and Scheduling Problem

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ABSTRACT

In the home healthcare routing and scheduling problem (HHCRSP), nurses are allocated to a variety of services demanded by clients during a planning horizon. The properties of this problem resemble vehicle routing and nurse scheduling. To propose an efficient solution, the authors consider various issues such as multi-depot, travelling time, time windows, synchronisation, the qualification levels, and other features of nurses and clients. In addition, the continuity of care and work overload should not be ignored in this perspective. First, the authors developed a model in which the continuity of care is redefined by considering connected (synchronous) jobs and the work overload is formulated considering nurse-to-patient staffing ratio. Second, a two-stage solution approach based on a cluster-assign algorithm and variable neighbourhood search (VNS) and variable neighbourhood descent (VND) algorithms are tested on a series of large-scale instances. Computational results present the relations and trade-offs among the aforementioned issues.

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1 INTRODUCTION

Home healthcare (HHC) can be defined as a wide range of medical and non-medical care services that clients/elderly people receive in their homes. The HHC services cover activities such as checking a client's eating and drinking habit, blood pressure, body temperature, breathing, and following upon their prescription and treatments. The aim of these services is to aid clients by improving their living conditions with greater independence, increasing their level of well-being/welfare, receiving care at home instead of hospitals and healthcare institutions over extended periods of time (medicare.gov, 2016). Moreover, compared with the traditional hospital care, HHC services have been found to be cost-efficient in case of certain diseases (NAHC, 2010).

Today, the importance of HHC is even more increased with advancing age and growing populations worldwide. According to the United Nations' (UN) report released in 2010, those at the age of 65 and older comprise 11% of the worlds' population, and this group is expected to grow by 26% by 2050. Therefore, it is estimated that the number of elderly people will be 400 million and 1.5 billion in the developed and developing countries, respectively. Statistics show that in 21 European countries the proportion of the number of 60 year-olds and higher to the entire population has exceeded 20% according to the 2013 figures (Health, 2015; Mattke et al., 2010).

The importance of supply chain management is currently indisputable, but the importance of health supply chains has received attention recently (Nagurney A., 2012). Due to the high cost of human logistics and supply chain management and limited funding available, it is important that countries and organizations make the most of the limited resources (Vaillancourt, Tatham, Wu, & Haavisto, 2018) . It is estimated that more than 40% of the financial resources used by the humanitarian logistics operation is wasted (Day, Melnyk, Larson, Davis, & Whybark, 2012). Pan American Health Organization underlines two important issues humanitarian supply logistics (PAHO, 2001):

1. Supply chain management should be an integrated approach. The alignment across the business processes and their interdependence should not be ignored in this framework. 2. Employing human resources appropriately and identifying their availability, capabilities, and locations are crucial activities. Therefore, the planning/scheduling and preparedness are important not only for countries, but also for organizations.

In the USA, it was calculated that HHC workers drive 7.88 billion miles (more than 40 round-trips to the sun) and 718 million visits in 2013 alone. In 2006, the estimated number of miles driven for these services was 4.76 billion. This means

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