CO_2 EMISSIONS IN HEALTHCARE LOGISTICS

ASSESSING THE EFFECTS OF GREEN LOGISTICS INITIATIVES

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ABSTRACT

Purpose

The purpose of the study is to find an ecologically sustainable delivery model for healthcare material logistics in reducing CO_2 emissions and reaching the societal goals of environmental sustainability.

Design/methodology/approach

The analysis is made by applying geographical information systems (GIS)-based route allocation, which is based on, and later referred to, the qualitative data from the interviews and focus group discussions.

Findings

The paper lists the most well/known and recent initiatives in green logistics/supply chain management and assesses their impact in reaching lower CO_2 emissions in healthcare logistics. Comparing back-and-forth and tour-based delivery routes results in 74 per cent fewer driving kilometres and 37 per cent lower CO_2 emissions for the latter scenario.

Research limitations/implications

The saving in driving kilometres follows the earlier comparisons between back-and-forth and tour-based delivery strategies. Savings in CO_2 emissions, however, are less due to the bigger vehicles in delivery tours. As a main implication, these results offer a calculated background for the next research phase, including discussions and interviews to clarify possibilities for environmental sustainability in healthcare logistics.

Practical implications

Hospitals, hospital districts, city organisations and privately-owned healthcare services can use the results in developing their services to reach the set and aspired goals in environmental efficiency.

Social implications

Societies are aiming for lower CO_2 emissions. Especially in the case region, the current healthcare reform offers momentum for renewing the logistics solutions to match the set goals.

Original/value

Healthcare logistics offer a novel perspective on environmental sustainability.

Keywords: Healthcare logistics, Green logistics, CO_2 emissions, Sustainability, Geographic Information Systems (GIS).

1 INTRODUCTION

Healthcare material logistics research has contributed to bringing cost efficiency and service improvements to healthcare systems (see e.g. Volland et al., 2017, Kotavaara *et al.,* 2017). The recent awareness towards environmental effects of transport arrangements calls to examine whether these two goals aim in achieving lower CO_2 emissions. By Harris et al., (2011), this is not the case, as optimising costs and services does not necessarily offer optimum solutions for CO_2 emissions. Therefore, planning healthcare material delivery routes with an aim to reach minimum CO_2 emissions can give new insights to both research and managers of healthcare logistics organisations.

This study compares two material delivery scenarios for primary healthcare facilities in the region of the Northern Ostrobothnia hospital district, located in Northern Finland. The central warehouse offers the care items for the health centres, but the transports are currently operated, first, by one outsourced transport route and, second, by the health centres themselves or using logistics service providers (LSP). Thus, the entity of the transport arrangements is quite blurred. The ongoing national healthcare reform drives the healthcare organisations and transport arrangements to be managed in a centralised manner. Therefore, the situation offers a fruitful case for analysing material delivering scenarios by optimising the routes in regard to minimising travel time and also CO_2 emissions.

The purpose of the study is to find an ecologically sustainable delivery model for healthcare material logistics. The empirical results from the case region are reflected in the current literature about healthcare logistics and compared to the metrics that are used in estimating the influences of CO_2 reductions. Hence, this research aims to contribute to answering the following questions: How do back-and-forth and tour-based delivery models differ by the CO_2 emissions? How much influence does optimising CO2 emissions have on societal sustainability goals? How can healthcare service organisations enhance their ecological sustainability?

2 SUSTAINABLE HEALTHCARE MATERIAL LOGISTICS

Logistics and supply chain management literature offer multiple classifications for green logistics. This paper focuses on factors influencing energy efficiency and environmental sustainability initiatives (see Centobelli et al., 2018), green initiatives adopted, innovated and optimised and self-organised by the LSP (see Pieters et al. 2012) and distribution strategies also in cooperation with customers (see Perotti et al. 2012; Colicchia et al., 2013). Further empirical analysis examines the impact of the selected two scenarios in the selected case, keeping in mind that logistics sustainability cannot be studied in isolation from other factors (like owning trucks and employing drivers) (See Nilsson et al., 2017).

3 METHODS AND OVERVIEW OF THE CASE

The case analysis is done by calculating two extreme scenarios 1. Every health centre picks up their own items from the central warehouse and 2. Delivery routes operated by one truck from the central warehouse. These back-and-forth and tour-based delivery routes are calculated by using Geographic Information Systems (GIS)-based transport accessibility methods (Miller and Shaw 2001), with actual road and healthcare facility data. CO_2 emissions are included in road network data as travel cost attributes in addition to minutes and kilometres (see Määttä-Juntunen 2011) by using average CO_2 emissions for different types of vehicles defined by VTT Technical Research Centre of Finland (cited 19.2.2019).

Among GIS methods, this paper uses qualitative case methods to give additional insights to these complex issues; alternating between the empirical field and different theoretical frameworks, this paper uses qualitative case approach (Orton, 1997; Yin, 2013). Thus, the background knowledge for the further analysis is collected in a qualitative case study manner, applying semi-structural interviews and focus-group discussions (See Stewart and Shamdasani, 2014, p. 178.) with managers and professionals from healthcare organisations from the case region.

The region has 412 000 inhabitants in the area of 40 000 km² resulting population density of 11,2 inhabitants per km². Most of the population are located in the city centres, leaving a majority of the region sparsely populated. Public special healthcare services are provided by the hospital district of the region, whereas the municipals are in response of the 46 public primary healthcare centres.

The materials needed in the care operations (no laundry and food) are tendered by the centralised purchasing organisation. The same organisation operates the central warehouse of the region operating the material flows from 600 suppliers to the public hospitals, health centres and schools in the region. Overall, the 46 health centres can be served by one delivery per week, with quantities varying between 0.7 m³ and 1.7 m³per week.

4 CASE ANALYSIS

In the back- and-forth collection scenario, each health centre picks up their needed goods from the central warehouse by using a van. This is done once a week by every 46 health centres in the region, resulting in 46 back-and-forth trips between each health centre and the central warehouse (see figure 5.1). This results in 7 570 driving kilometres causing 1 263 CO_2 kg of emissions weekly. The tour-based delivery, with a 15t truck, results in 1 939 driving kilometres and a weekly CO_2 emission of 801kg (see table 4.1).

Table 4.1 Comparison of CO_2 emissions of back- and-forth collection and tour-based delivery routes

	Back-and-forth collection Van 2.7 t with load (46 routes – 46 sites)	Tour-based delivery Truck 15t with load (5 routes - 45 sites)	Saving	Saving %
km	7 570	1 939	5 631	74
min	6 608	1 970	4 638	70
min (+shelving)	7 528	2 420	5 108	68
CO2 kg weekly	1 263	801	462	37
CO2 kg annual	65 696	41 636	24 060	37

When comparing the two scenarios (figure 4.1), the tour-based delivery offers the most significant savings in both driving time, 70%, and driving kilometres, 74%, compared to the back-and-forth scenario. The CO_2 emissions are also lower (34%) even though the kilometres are driven with a heavier vehicle with bigger CO_2 emissions per km. A weekly savings is 465 kg, which is 24 060 kg annually.

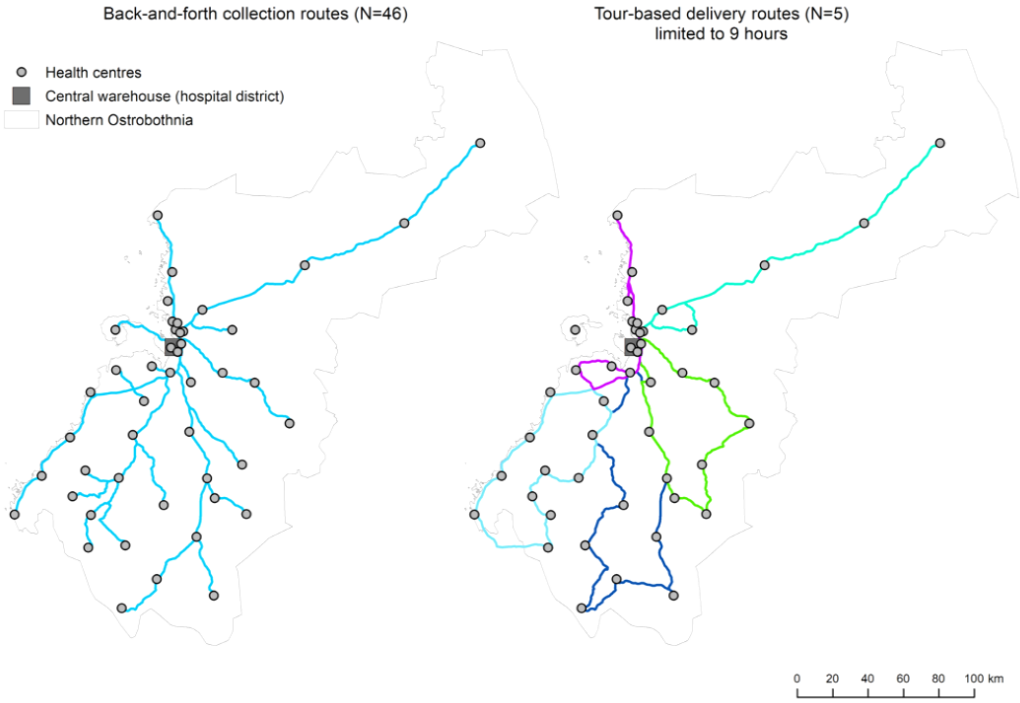

Figure 4.1 Back-and-forth collection routes and tour-based delivery routes on map

5 CONCLUSIONS

This study discovers a calculated basis for discussion about an ecologically sustainable delivery model in healthcare material logistics. The back-and-forth and tour-based delivery models differ, as expected, significantly by the driving kilometres and time, but also CO_2 emissions can be decreased by 34 per cent. With this kind of change, the case healthcare system can annually decrease 24 CO_2 tonnes that can be considered somewhat marginal. However, a percentage saving of 37% appears significant through the possibilities to be scaled also to other regions and to other health and social services, such as elderly care. Additionally, these savings can be attained with a fairly straightforward delivery strategy change that simultaneously impacts in increasing service level, lower costs, and, thus, better environmental sustainability

Overall this study offers two imaginary and extreme scenarios of which neither is in use at the moment. However, this paper gives an overview of the dynamics of how these extreme scenarios differ in offering the same service. Further study will clarify how healthcare service organisations can enhance their ecological sustainability based on this examination.

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