Transport Policy 44 (2015) 37–47

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

How logistics performance of freight operators is affected by urban freight distribution issues

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ARTICLE INFO

Article history:
Received 9 October 2014
Received in revised form
3 June 2015
Accepted 22 June 2015

Keywords:
Regulations
Collaboration
Logistical performance
Detour

ABSTRACT

This article is to shed light on the interactions among the various freight distribution constructs such as regulations, collaboration, detour, load/unload interfaces and logistical performance. The proposed model is empirically tested using Partial Least Squares with 119 freight operators. The findings reveal the moderating effect of regulations (negative effect) on the positive relationship between collaboration and load/unload interfaces regarding receivers and freight operators. According to the effects shown by our model, regulation, along with lack of collaboration, appear to be the Achilles' heel of freight distributors, in that both factors contribute (directly and indirectly) to detour, which results in less efficient logistical performance.

1. Introduction

Economic growth in metropolitan urban areas is resulting in increasing demands from private and public companies for goods and services (Cherrett et al., 2012). As a result, demand has risen for freight transportation services and land use in dense urban areas. Moreover, freight activities to and from warehousing and distribution facilities in these areas have become increasingly decentralised (Cidell, 2010), heightening concerns about the reliability and maintenance of urban infrastructure. Urban freight management is often hampered by a high number of stakeholders (Stathopoulos et al., 2012), each focusing on their own activities to the detriment of systematic comprehension of interactions among several constructs (e.g., land use, type of goods moved, nature of transfer operations, relationship between goods type, truck type and operating partners, and effect of regulations) (Woudsma, 2001). Most delivery occurs without a full understanding of the freight distribution system (Nuzzolo and Comi, 2014) with regard to suitable vehicle parking, loading, and unloading. From a strategic point of view, there is no joint planning among the distribution-chain stakeholders. Issues such as traffic congestion, thefts, and truck restriction have increased over the past two decades and challenged truck operators in the freight distribution system. For example, the reduction of stockholding space in urban shops, offices, and factories has resulted in increased demand for reliable, regular, flexible delivery of relatively small quantities of products (De Vasconcellos, 2005). However, retailers may not consider that suitable parking and unloading areas, and personnel to unload or examine the vehicles/goods at the receiving establishment, are required.

Two factors may result in inefficient freight distribution systems in dense urban areas. First, the lack of collaboration between logistics service operators and receivers has indirectly contributed to such problems as traffic congestion and use of unsuitable unloading and parking areas. For example, without information or flexibility to deal with contingencies, operators may cause traffic congestion when delivering goods by using unsuitable parking areas to unload. Second, governmental regulations aimed at decreasing traffic congestion, harmonising land use, reducing environmental burdens, and improving logistical flow can directly and negatively affect the freight distribution system by exacerbating imbalance between use of “light goods vehicles” and land availability for parking, loading/unloading areas, and traffic safety. Freight distribution issues are sometimes affected more negatively by regulations than by lack of collaboration between the companies. Moreover, regulations have an indirect negative impact on firms' logistical performances: by increasing the number of vehicles circulating in central areas and restricting truck circulation (Thompson and Taniguchi, 2001), regulations can create more traffic congestion (De Vasconcellos, 2005) and necessitate the use of narrow streets and unsafe areas to deliver goods. In turn, these factors increase delivery time and the range of vehicles needed, and make it more difficult to schedule alternate routes.

The objective of our article is to shed light on the interactions

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http://dx.doi.org/10.1016/j.tranpol.2015.06.007
0967-070X/

among the various freight distribution constructs related to traffic congestion, urban infrastructure and its regulations, collaboration between partners, logistical delivery aspects of goods, and firms' logistical performance constructs. Specifically, our research highlights the direct, indirect, and moderating effects of governmental regulations, as well as the lack of collaboration among firms. To our knowledge, there is no study of the interaction among the freight distribution constructs, and literature that examines the impact of the regulation, lack of collaboration, detour and load/unload interfaces (e.g., lack of parking, loading/unloading areas) on distribution performance of the companies (Anderson et al., 2005; Hesse and Rodrigue, 2004) is limited. Therefore, a contribution of our research is to provide a model that measures these impacts according to firm size. We also investigate the moderating effects of regulations on the relationship between collaboration and load/unload interfaces among the companies, and add to the negligible amount of literature on the importance of in-depth regulations analysis to the improvement of company logistical performance. We use the São Paulo Metropolitan Region (SPMR), the sixth largest metropolitan region in the world, as an example of a megacity that presents many urban freight distribution issues. We believe the lessons of the research results extend to other megacities and large cities.

In this article, based on theoretical background, we develop separate hypotheses for specific relationships between constructs, with regard to the main constructs. Next, we outline our methodology, including the framework of constructs and respective indicators. We follow with empirical data analysis and results, including a measurement model and a structural model, and present our discussion and conclusions, including theoretical, managerial and governmental implications, study limitations and opportunities for further research.

2. Theoretical background and hypotheses

2.1. Effects of regulations

Municipalities have implemented traffic regulations in transportation systems to reduce vehicle congestion and improve mobility and traffic organisation in large centres (Dablanc, 2007). However, they typically address such easy-to-implement factors as vehicle weights and time zones (Behrends et al., 2008). Although several cities have successfully mitigated traffic congestion by implementing truck restrictions, negative externalities have emerged from this controversial policy. Woxenius (2012) argues regulations add restriction zones that can cause "detour," the term we use to refer to a result of traffic congestion, narrow streets and unsafe delivery areas. For example, traffic congestion may be increased when several competitors serve less-than-truckload markets where there are truck restriction zones. Castro and Kuse (2003) report regulations such as truck restriction zones and restricted timetable circulation significantly increase total vehicle-kilometres, vehicle-hours, and use of many smaller vehicles to complete the deliveries, in addition to increasing traffic congestion (Lindholm and Behrends, 2012). These restrictions also contribute to an increase in use of unsafe areas and alternate routes that have physical constraints such as narrow road widths and low vertical clearances (Castro and Kuse, 2005). According to Holguín-Veras (2010), restrictions are frequently placed on the use of large trucks without considering that trucks are more efficient than smaller vehicles. Therefore, large truck restrictions can ultimately increase smaller truck traffic and result in more externalities than those produced by large trucks. The author illustrates this concept with two important externalities: pavement deterioration and road space consumption. Thus, we formulate the following hypothesis:

H1. Regulation is positively related to detour.

In addition, strict timetables and zone circulation for cargo vehicles restrict availability of parking and unloading areas and contribute to an increase in long queue, which can in turn cause detour. Munuzuri et al. (2005) argue that due to limited time windows and lack of suitable parking and unloading areas (Cherrett et al., 2012), freight vehicles are often forced to enter congested areas during peak hours, thus worsening traffic detour and resulting in more delivery delays, increased theft, and increased use of many small delivery vehicles. Therefore, we derive the following two hypotheses:

H1a. Load/unload interfaces mediate the positive effect of regulation on detour.

H1b. Detour mediates the positive effect of regulation on logistical performance.

2.2. Effects of collaboration on relationship between logistical service operators and receivers

A high level of coordination is required in an integrated freight distribution system (Hesse and Rodrigue, 2004). Many companies may be connected to one another to deliver goods to end users; they must also address traffic issues, significant demand increases, high-frequency deliveries in lighter vehicles, and deliveries in risky urban areas (Crainic et al., 2004). Our research focuses on collaboration aspects that involve sharing logistical information, flexibility, and commitment between freight operators and retailers during goods delivery. Sharing logistical information is important because not all companies use information technology. Increased information sharing in logistical operations may solve logistical contingency issues among the partners (e.g., availability of loading and unloading areas, parking areas). Flexibility is also important: for example, firms could arrange to deliver goods at off times or provide dedicated logistical operation time to delivery for key accounts. Furthermore, relationships based on commitment between partners (Morgan and Hunt, 1994) may lead to service level improvements and reduce order cycle times and inventory levels (Moberg et al., 2002).

Characteristics of the relationships between operators and receivers have strong impacts on the delivery decision in terms of aggregate times and costs; operators are more likely to aggregate costs alone if there is relatively less time available to satisfy the delivery (Puckett and Hensher, 2009). In this case, the stricter time window exerts pressure on the retailer to be flexible on when goods are received. However, retailers incur greater costs from off-peak delivery than operators (Holguin-veras et al., 2005). As a result, shippers and operators can significantly influence delivery times, while receivers have little input into when the vehicles arrive (Cherrett et al., 2012). Truck operators focus on fast delivery of goods and demand better accessibility (mainly off peak hours), traffic information, and control of loading/unloading bays (Stathopoulos et al., 2012); they generally prefer routes with many stops over a single delivery (Figliozzi, 2010). In contrast, receivers prefer to receive goods during the day (Domínguez, et al., 2012). Therefore, a retailer's lack of temporal flexibility and reluctance to receive goods in peak delivery due to daily commercial activities, combined with the shipper's failure to divulge delivery time, may result in operators parking and unloading vehicles in unsuitable places. Therefore, we derive the following hypothesis:

H2. The lack of collaboration is positively related to load/unload interfaces.

Detour is also indirectly influenced by a lack of collaboration between partners. Because partners have different interests in freight distribution systems, related to time and local delivery issues, they are not willing to collaborate with one another, assume