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An evaluation of urban consolidation centers through continuous analysis with non-equal market share companies

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Abstract

This paper analyzes the logistic cost savings caused by the implementation of Urban Consolidation Centers (UCC) in a dense area of a city. In these urban terminals, freight flows from interurban carriers are consolidated and transferred to a neutral last-mile carrier to perform final deliveries. This operation would reduce both last-mile fleet size and average distance cost. Our UCC modeling approach is focused on continuous analytic models for the general case of carriers with different market shares. Savings are highly sensitive to the design of the system: the increment of capacity in interurban vehicles and the proximity of the UCC terminal to the area in relation to current distribution centers. An exhaustive collection of possible market shares distributions are discussed. Results show that market shares distribution does not affect cost savings significantly. The analysis of the proposed model also highlights the trade-off between savings in the system and a minimum market share per company when the consolidation center is established.

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1. Introduction

Urban goods distribution is indispensable for the economic development of cities but it contributes to the worsening of several issues related to traffic congestion and the environment. Stakeholders of urban systems are affected in some

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way by these problems. On the one hand, carriers spend most part of their time (up to a 28% of overall logistics costs) in last-mile distribution due to the increasing levels of traffic congestion, lack of unloading/loading zones, and other inefficiencies (Goodman, 2005; ASCE, 1998). On the other hand, urban citizens often undergo environmental effects like pollution, noise, or space competition. Furthermore, the carrier's customers become more and more demanding in terms of time windows, frequency and competitive prices.

The problem of establishing effective operative measures to improve urban distribution is a challenge because it arises in the context of a heterogeneous market with multiple types of products, roles, and conflicting objectives. Even if urban distribution causes great inconveniences in most cities, there is usually a lack of guidelines or leadership from the local authorities to regulate and organize distribution in order to make it more efficient. Thus, there is a special need for innovative solutions, both involving public and private parties, to be able to generate attractive benefits for both, companies and urban citizens (McKinnon, 2008).

In this paper we will propose a strategic solution that entails cooperation between freight carriers for the common use of a public freight terminal located near the distribution area. The main idea behind our approach is to schedule urban distribution in two separate phases. The first one takes place during certain time periods (preferably at night), when carriers from all companies bring their goods to an Urban Consolidation Center (UCC). The second phase takes place during the day, when a neutral freight carrier performs, jointly for all companies, local delivery in the areas with higher customer density. Such a system implies several advantages with respect to a system without a UCC in which each carrier is responsible for distributing its goods to all its customers. In the first phase, the system allows transport operators to use larger vehicles to bring their load to the UCC with fewer time restrictions. Furthermore, the last mile´s negative effects of the second phase are also considerably reduced since local deliveries are performed more efficiently and with less environmental impact due to the consolidation of goods.

1.1. Literature Review

Several contributions exist in the literature related to our work. Roca-Riu et al. (2012) presents a model to estimate distribution costs in an urban area under a simplifying assumption: the equal market share among transport companies. Systems of a similar nature to the one we propose which allow different market shares, are presented in Köhler (2001) or Ieda (2010), who describe specific implementations of UCC systems in German cities or in Japan respectively. These results apply to each case study, but no general analysis is included and therefore it is difficult to extrapolate the results. Saberi et al. (2012) presents a similar approach in the continuous model of general applicability, but its focus is to minimize emissions at the strategic level.

There are other published works presenting models that analyze the effects of collaborative strategies in urban distribution. Kawamura and Lu (2008) follows a methodology with points in common to the one we use, although their modelling hypotheses, which are somehow different from ours, have been adapted to an urban-interurban American context. In particular, some of the modelling hypotheses they consider are: holding costs, the adjustment of the frequency of dispatch, and that big trucks may enter the city without problems. Rarely do such hypotheses and context values hold for the dense urban contexts of many European cities. Later in 2012, Chen et al. (2012) presents a more general model including the European context in terms of customer density, facility location or vehicle type. However, modelling hypotheses differences remain. Moreover, it is assumed that all transport companies serve all customers, which seems unrealistic from a practical point of view. In contrast, our approach encompasses any market distribution among companies. Furthermore, we also address the non-homogeneous demand case.

A totally different approach to analyse collaboration strategies has been followed in (Krajewska and Kopfer, 2006; Krajewska et al. 2008), who address the cost allocation problem. This problem studies the distribution of new costs and its benefits due to the collaborative process among participants. The methodological framework of this approach considers both combinatorial auctions and operational research game theory. Indirectly, they use collaboration models to obtain data for cost allocations.