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Integrating c2e and c2c traffic into city logistics planning

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Abstract

City Logistics generally addresses inbound movements, from regions outside the city to the zone under City Logistics control. Integrating outbound and intra-city traffic may contribute to make freight transportation more efficient and less intrusive on mobility, the environment, and general quality-of-life conditions in the city. It may also raise significant managerial and methodological challenges, which increase with the degree of integration of fleets and operations. We describe and analyze a number of representative service-integration scenarios, discuss operational and managerial issues, examine corresponding methodological challenges, and identify associated research avenues.

Keywords: Integration strategies; inbound, outbound and intra-city traffic; management issues; methodological challenges

1. Introduction

Most City Logistics (*CL*) literature and projects address *inbound* movements only, reflecting the dominant position the traffic proceeding from the exterior of the city towards its centre occupies within the travel patterns observed in most cities. Yet, the volumes of freight produced within the city and shipped to locations within or outside it may be significant. Due to their particular nature and handling requirements, refuse and recyclable products are not considered here. Given the mobility, environmental, and quality-of-life objectives of City Logistics, it is relevant to investigate the possible integration of these traffic types into "normal" CL operations. The goal of this paper is to contribute to this investigation.

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We consider two types of traffic, *customer-to-customer* (*c2c*), and *customer-to-external zone* (*c2e*), the former representing traffic originated and destined to customers located within the CL-controlled part of the city (that we name *city centre*), the latter representing shipments from the city centre to destinations outside the city limits. Integrating these flows together with the "classical" *external zone-to-customer* (*e2c*) into a single CL system, facilities and vehicles serving simultaneously several traffic types, would presumably contribute to make freight transportation more efficient and less intrusive on the quality of life and the environment of the city. The planning, management, and control activities required by such integration might prove difficult to implement in practice, however. There are, in fact, several levels of service integration that may be contemplated. A thorough evaluation of the expected behaviour and operational efficiency of the resulting CL system, including a cost-benefit analysis, is thus required to compare them and contrast potential gains in system efficiency and city benefits to the corresponding managerial and operational burden. This would provide the basic elements to evaluate tradeoffs and select the policy most appropriate for specific application contexts.

There is, however, a significant gap in knowledge and instruments required to accomplish these objectives. Basic concepts and issues need to be explicitly identified. Most models, methods, and algorithms need to be developed, and the methodological challenges are significant. This paper establishes the basis to fill this gap. We describe and analyze a number of representative service-integration scenarios, and discuss operational and managerial issues. We also propose and examine an operational policy called *Pseudo-Backhaul* to simplify particularly complex service-integration scenarios, while still providing a high level of service flexibility and system efficiency. We finally examine the methodological challenges associated to these scenarios and identify associated research avenues. Two-tiered CL systems [1] present many management and methodological challenges and thus offer a rich analysis framework for our work. The next section recalls this setting.

2. City Logistics

The basic purpose of City Logistics is to reduce the impact of freight-vehicle movements on the city-living conditions, particularly by enhancing the congestion-and-mobility conditions, improving vehicle utilization, and reducing emissions and pollution, without penalizing the city social and economic activities. A description of City Logistics, including relations to freight transportation networks, in general, and postal and courier networks, in particular, is presented in [2]. Most CL projects are based on consolidating inbound freight before moving it into the city centre using the coordinated routes of a number of vehicles [3]. Consolidation takes place at one or several major terminals sited at the city limits and known under various names including City Distribution Centres (CDC). Single-tier CL systems, found mostly in small and medium-sized cities, implement *direct-distribution* strategies, serving customers in the city centre by vehicles operating tours starting and finishing at some CDC facility. Two-tiered CL systems [1,2], deployed or planned for large cities, are based on a so-called *consolidation-distribution* strategy, which uses a second level of facilities and different vehicle fleets in order to avoid the presence of large vehicles in the city centre, and to reduce the number and length of empty trips.

Sorting and consolidation activities in two-tiered CL systems are performed at facilities organized into a hierarchical structure, as illustrated in Fig. 1: major terminals sited at the city limits, the so-called *external zones* (squares in Fig. 1) and *satellite* (triangles) facilities strategically located close to or within the city centre. Particular vehicles are dedicated to each system tier, medium-sized *urban vehicles* operating at the first tier (dashed lines) and smaller and "green" *city freighters* performing tours (full lines) at the second tier. Satellites are generally intended to be simple transhipment facilities and operate according to a vehicle-synchronization and cross-dock transhipment model, i.e., urban vehicles and city