An evaluation of current decision support systems for urban freight transport planning and their adaptability in multi-stakeholders contexts

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1. Introduction

With the growth of the population share living in urban areas, over recent decades, interest and awareness in urban logistics and transport activities has been steadily growing in both the research environment and wider policy context. Significantly, advances in urban logistics operations and improved local authority planning are seen as essential in order to alleviate the associated negative environmental and economic impacts occurring in cities (Lindholm and Behrends, 2012).

Several types of actors and stakeholders are therefore involved in such urban logistics management processes. Among them, freight carriers and shippers are interested in minimizing freight logistics costs in order to maximize their profits, while maintaining a competitive level of service to their customers. City administrators and residents are oriented towards a decrease in traffic congestion, social costs and environmental nuisances, even though they are often direct beneficiaries of high quality delivery services. This leads to a multitude of differing and possibly conflicting objectives that are involved in urban freight transport planning and decision making, yielding a high level of complexity and providing a strong motivation for the development of tools for helping decision-makers to reach higher grades of efficiency.

Decision support systems (DSS) can offer mechanisms and metrics that can provide useful basis for informed decision-making at an organisational level. They rely on an extensive use of operational research and data analytics techniques in order to predict and create scenario outcomes that can ease the decision-making process, provide comparisons of alternative courses of action and optimise a variety of objectives.

Although potentially positively impacting, the adoption, on a systematic basis, of Decision Support Systems in urban logistics practice has been limited, so far, by a variety of reasons. Indeed, despite an increasing number of advanced models and powerful algorithms presented in the literature for optimizing Urban Logistics, planning-oriented Decision Support Systems (DSSs) are seldom considered by private and public agents as tools to be adopted for practical purposes within real-world decision making processes. This is partly due to the fact that these models and methods rarely incorporate a multi-stakeholder perspective in their analysis, often resulting in centralised and hierarchical decision-making procedures that might be of little help in contexts where a more participatory approach is required.

However, advancements in the scientific and technological development of DSSs, designed and implemented in strict cooperation with potential beneficiaries such as local authorities, transport planners and private sector logistics operators, have the potential to increase the adoption of innovative model-driven DSS approaches in real-world urban logistics.

In this contribution, a review of the extant literature will be provided. In particular, an overview of emerging themes within the current state-of-the-art will be provided. Also, the review will be looking at the building blocks of DSSs, such as: the adaptation of classical logistical decision-making problems to the urban context; the development of key performance indicators for evaluating logistical systems within multi-criteria decision-making frameworks; the promotion of integrated decision support tools for advancing the practical application of approaches developed in the academic literature to everyday scenarios. At the same time, a review of currently commercially available DSSs for logistics planning will be performed, in order to highlight gaps between theory and practice.

2. Preliminary Findings

Alternative delivery modes, time-based strategies and urban consolidation centres are some of the main solutions being utilised by local authorities for addressing freight mobility challenges in urban spaces. Some of these solutions (such as UCCs) are becoming increasingly attractive options within Europe and one that is being embraced by local

authorities across board (Battaia et al., 2014). However, a significant drawback to the implementation of such solutions is represented by the high set-up costs and the subsequent operations priority assignments once running (Leonardi et al., 2014). Additionally, the implementation of urban logistics solutions can create stakeholders conflicts as carriers' operations might be significantly disrupted (Van Duin et al., 2016).

Given the relatively low success rate of urban logistics initiatives (for instance, UCCs) especially in mainland Europe, contemporary and future initiatives have to be based on careful planning, and on the usage of appropriate DSSs for maximising success rates.

The successful case studies suggest that these elements of implementation are critical and the successful application of appropriate decision support systems is crucial to the implementation. Unfortunately, at the moment, approaches developed in the academic literature (mainly tested on numerical examples or on ad-hoc case studies) exhibit a low degree of transferability to real-world situations; at the same time, the lack of general-purpose systems aimed at decision-aiding in the field of urban logistics means that local authorities need, in most of the cases, invest significant resources in the creation of ad-hoc tools that might not be reutilised for future projects. Also, such investments might be problematic in an era of austerity, cuts to public expenditure and limited budgets. Findings highlight weaknesses in stakeholder modeling and excessively operational level focus that creates dichotomies between DSS models and their use by local authorities. The implications are instructive for future developments in the field and highlight the relevance of strategic level tools with capacity for complex scenario planning, optimal resource evaluation and stakeholder prioritization.

Based on initial conversations with public sector stakeholders, it emerges that a critical area for impact would be the possibility of turning *common operational tools* (designed, for instance, for the management of existing systems, such as UCCs) into strategic decision support systems (that could be utilised also by other stakeholders in the industry).

In particular, scenario planning functionalities would be very useful in the phase of strategic design of urban logistics solutions. As such, the development of core strategic tools that offer decision support beyond operational levels is critical to advancement in the field of sustainable urban logistics. Such strategy-based tools with capacity for scenario planning and optimal resource and stakeholder prioritisation can effectively move local authorities beyond the complexities of the many operations tools into single user friendly and optimal decision frameworks.

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