1. Introduction

The City Logistics problem arises from the tension between the strategic behaviour of the private agents (retailers, suppliers and logistics service providers), each independently optimising their logistics operations, and the social optimum pursued by the city planner. In the current paper we consider a limited urban area populated with \( n \) retailers, for instance the stores in a shopping mall or on a commercial street. Each shop independently optimises its logistics operations to minimise its transportation and inventory costs, and many of these stores might be organised as parts of bigger retail chains consolidating deliveries from different suppliers in a cost-efficient manner.

However, from a city perspective such system of independent agents can still be unsustainable, generating inefficiencies and externalities to other retailers and to the society. This is due to (1) the lack of economies of scale since many retailers are not big enough and therefore underutilising goods vehicles, making frequent under-loaded and empty trips; (2) the fact that retail chains optimise their deliveries from an “origin-perspective”, while a “destination-perspective” is optimal for the city as a whole, hence contributing to traffic congestion in the urban centre, creating queues at the loading/unloading bays and parking lots, generating air and noise pollution.

A well known policy dealing with the city logistics problem is the construction of an Urban Consolidation Centre (UCC), a shared transhipment platform where several suppliers deliver freight and from which consolidated deliveries take place. In the current work we focus on the economic impact of the UCC, creating queues at the loading/unloading bays and parking lots, generating air and noise pollution.

In the next section we summarise some of the guidelines provided by the UCC literature. The aim of the current work is to explore in a quantitative manner the problem of financial sustainability of the UCC scheme. In order to do so, we focus on the economic impact of the UCC scheme on each single agent, modelling their decision making behaviour when facing the choice between joining or not the consolidation centre. We argue that such decision has two main components:

1) a strategic component in which a retailer’s decision of joining the UCC depends on the other firms’ decision as well. We provide a simple game theoretic model to find the conditions such that joining the UCC is a dominant strategy.

2) an economic component where a firm’s decision in joining the UCC is based on a cost/benefit analysis, namely an agent will join the scheme if the benefits it receives are greater than its costs. We argue that the logistics costs of a firm depend on its structure (number of branches, location of the branches, number of trucks owned) and on the demands faced at the location covered by the UCC.

In general, there is a need for further research in order to provide city planners with better tools to implement UCC schemes to tackle the urban logistics problem. Further, there is a need to study the impact of the UCC scheme not only from an environmental point of view, but also its economics impact on each single agent and on the overall logistics system.

2. Related Literature

From several case studies, researchers and practitioners have drawn general guidelines on the implementation of an UCC scheme. Ville et al (2012) describes the case of Vicenza (Italy), where the city planner gave the monopoly of the whole urban freight distribution to the consolidation centre, making de facto freight distribution a public service. However, the Vicenza UCC has struggled to become financially sustainable and relied on public subsidies. Further the Vicenza UCC has been forced to compete with private logistics service providers outside the monopoly area due to lack of demand for freight transportation in the city centre. Another seminal case study is the Motomachi UCC in Yokohama (Japan) described in Rodrigue et al (2013), where the scheme was initiated by the retailers of a high-end shopping street in order to solve the problems of double parking, shopping window visibility and congestion, hence with the aim to improve the overall commercial experience.

Drawing from the above and other experiences, we report below a list of factors which researchers have identified as determinant for the sustainability of the UCC scheme:

- many UCCs failed due to the lack of demand. Hence, in order to guarantee financial sustainability for the UCC scheme, a large enough number of stores should join the scheme.
- the UCC is more successful when a clear problem exist ex-ante its construction. Hence, when the UCC is justified by the presence of externalities, such as high congestion costs at the loading/unloading bays.
- an important limitation of the UCC scheme is the initial high investment required to set up the UCC facility.
- in many cases an UCC scheme is sustainable only if supported by the local authority, for instance through subsidies.
However, little work has been done in quantitatively assessing the above factors such as demand for the UCC, financial stability, UCC cost sharing. In particular, while several studies provided qualitative assessments on the UCC experiences, few studies have treated the financial sustainability of the UCC schemes (Browne, 2005).

In the papers by Triantafyllou et al. (2014) and van Rooijen and Quak (2010) a confrontation of before and after the implementation of an UCC scheme is provided. However, in both studies the problem of financial sustainability of the UCC is treated considering different possible scenarios under which a different number of retailers join the scheme. The current work is closer to the recent paper by Simoni et al. (2015), which argues that economies of scale are important for the sustainability of an UCC and proposes the use of economic theory to the assessment of an UCC scheme. However, while Simoni et al. (2015) focus on the optimal location problem of the UCC facility, in the current work we consider the decisional process of joining the UCC by private agents.

3. Problem framework and discussion
In the current section we introduce a framework to study the strategic component of the firms’ decision to join an UCC scheme. We consider the case of two retailers, both located in the same shopping mall. Each store receive goods from two different suppliers which supply only those two retailers. We call firm vertically integrated entity formed by a supplier which deliver to a single retailer. Hence in the current framework the two actors are the two independent firms 1 and 2. Each firm has a one time choice of delivering freight directly at the mall m or to the UCC u. In the first case the firm i will incur a general cost $c_m^i$ to drive up to the mall plus a congestion cost $c_m^f$. Congestion cost arise for instance when the mall has a single parking lot and the concurrent firm is already occupying it. In the second case, firm $i$ incur the following costs when delivering to the UCC: a general costs $c_u$, plus a UCC fee $f$. We consider the UCC as a cost sharing facility, where the participating fee $f = A_u / n$ where $A_u$ is the total cost of running the UCC and $n$ is the number of firms joining the UCC scheme.

The above case of the two firms is represented in Figure 1. The above case is extended to generalise the problem. In the case of more than two firms we can draw several preliminary analyses. One condition for the strategy “joining the UCC” to be dominant is that all firms 1 and 2 cost of delivering at the UCC should be smaller than the cost of delivering at the mall and that the difference in the costs is bound between the cost of joining the UCC if both firms join ($A_u / 2$), and the difference between the total cost of the UCC and cost of congestion. In other words the saving in transportation cost should be smaller than the cost of joining the UCC and greater than the cost incurred by the UCC minus the foregone congestion cost.

Generalising the model to n retailers we can explore several research questions: (1) is there a critical mass (number of shops joining the UCC) in order for the UCC to be sustainable and is this critical mass a possible equilibrium in the model (hence if it is attainable); (2) in the case it is not possible to reach such critical number of stores, what is the amount of required public subsidy needed to make the UCC sustainable; (3) in the case the critical mass is reachable, under which cost structure we can achieve it.

While in the above described framework we have considered the strategic component of the decision of joining an UCC scheme, which we argued is a fundamental process in assessing its financial sustainability, we haven’t treated the economic component of the retailers behaviour toward an UCC. Namely, we are interested in understanding the effect of the UCC on the whole business model of the private agent, and especially we are interested in understanding which business models benefits the most from the UCC scheme. In order to explore this last research questions we will consider a case study of a shopping mall in Singapore and propose the implementation of a single-site, one landlord UCC.

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