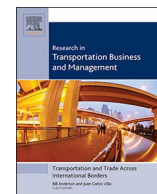




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Investigating the financial viability of urban consolidation centre projects

Milena Janjevic*, Alassane Ndiaye

Université libre de Bruxelles, Avenue F.D. Roosevelt 50, CP 165/4, BE-1050 Brussels, Belgium

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ABSTRACT

Urban consolidation centres (UCCs) are a popular measure in city logistics. However, many UCCs strongly rely on government subsidies and are granted a short life because of their inability to reach financial sustainability. Despite the interest from both the practitioners and the research community in this city logistics scheme, there are a limited number of quantitative contributions that investigate the financial viability of UCC schemes. This paper provides a comprehensive theoretical framework for testing the financial viability of UCC cross-docking and consolidation operations and applies it to a specific case of a UCC servicing Brussels. Major cost categories are identified and human resources are pinpointed as a major cost category. The paper demonstrates that profitable operations are in theory possible but that profits are highly fragile and subject to efficient use of resources. The paper identifies a series of operational metrics that drive the profitability of UCC operations and highlight that the efficient organization of distribution operations has a major influence on its financial viability. Finally, the paper discusses the influence of the size of vehicles and service area on the UCC profitability.

1. Introduction

Urban consolidation centres (UCCs) are a popular measure in city logistics (Verlinde, Macharis, & Witlox, 2012; Ville, Gonzalez-Feliu, & Dablanc, 2012) with 114 documented implementation cases in 17 countries (Allen, Browne, Woodburn, & Leonardi, 2012). A UCC can be defined as a logistics facility situated in relatively close proximity to the geographic area that it serves (e.g. city area or a specific site) to which many logistics companies deliver goods destined for the area and from which consolidated deliveries are carried out (Allen et al., 2012). A range of other value-added logistics and retail services can also be provided in these facilities (Allen et al., 2012). Broadly speaking, the key purpose of the UCCs is the avoidance of the need for goods vehicles to deliver part loads into urban areas (Browne, Woodburn, & Allen, 2007). For this reason, introduction of the UCCs is in fact an appealing policy which aims at changing the quantity and quality of deliveries (Danielis, Rotaris, & Marcucci, 2010). However, although UCCs have indeed demonstrated their ability to decrease the freight vehicle kilometres in an urban area (Verlinde, 2015), many of these projects are granted only a short life (Holguín-Veras & Sánchez-Díaz, 2016; Van Duin, 2009; Van Rooijen & Quak, 2010; Verlinde et al., 2012). The failure of the UCC schemes in the past has resulted in significant concerns with regards to their financial viability (Quak & Tavasszy, 2011) and numerous authors (Lewis, Lagrange, Patterson, & Gallop, 2007; Quak & Tavasszy, 2011; Van Duin, 2009; Allen et al., 2012; Gonzalez-Feliu, 2011; Van Duin, van Kolck, Anand,

Tavasszy, & Taniguchi, 2012; Panero, Shin, & Lopez, 2011; Browne, Sweet, Woodburn, & Allen, 2005; Verlinde et al., 2012) highlight the dependency of these facilities on public subsidies.

Despite the financial viability being one of the major issues in the UCC projects, information about their costs and benefits is rather scarce. Indeed, there is lack evidence-based information about scheme viability (Woodburn, 2005) as UCC projects are too often based on intuition than on a quantified assessment (Browne et al., 2005). We can, however, highlight several contributions that provide interesting input for the study of the financial viability of the UCCs. Very few studies address ex-post financial evaluations. A notable exception is the detailed assessment of the UCCs in La Rochelle and Monaco performed by the French Environmental Agency (ADEME, 2004) which provides comprehensive financial results for these two UCCs. The most common approach in literature are ex-ante financial evaluations that have been performed by a number of authors for a number of specific cases (e.g. Lewis et al. (2007), JMP (2011), Van Duin, Quak, and Munuzuri (2008), Van Duin, Quak, and Muñuzuri (2010), Wilson (2010), LaMilo (2015)). These constitute interesting contributions to the general understanding of the financial viability of the UCC schemes. However, there is a lack of a general framework that goes beyond the specific local conditions in which these studies were performed. On the other hand, there are a number of contributions that do not address directly the financial performance of the UCCs but provide information about their operational characteristics (e.g. UCC surface, number of staff, UCC throughput) that can serve as a basis for the quantification

* Corresponding author.

E-mail addresses: milena.janjevic@ulb.ac.be (M. Janjevic), abndiaye@ulb.ac.be (A. Ndiaye).

some elements of costs and benefits. For example, Boudouin (2006) provides a general operational framework for the UCC operations whereas Browne et al. (2005) provides real-life operational data on a number of UCC trials and implementation cases through an extensive literature review.

In this framework, this paper aims at providing a closer look into elements influencing the financial viability of UCC schemes and addressing the following questions: (1) which are the components of costs and revenues linked to UCC operations and how are they linked to its operational characteristics? (2) Which metrics drive these costs and benefits and consequently the financial performance of the UCCs?

Authors will establish a generic framework for the quantification of the costs and benefits linked to the UCC operations based on the existing literature on the subject. This generic framework will then be applied to a realistic case of the UCC implementation in Brussels.

The present study considers only consolidation and cross-docking operations at the UCC. Some recent UCCs experiments offer a range of additional services (e.g. temporary storage, packaging, pre-retailing) (Allen et al., 2012; Panero et al., 2011; Triantafyllou, Cherrett, & Browne, 2014; Van Rooijen & Quak, 2009) that can improve the overall supply chain performance, produce additional revenue streams and consequently improve the financial viability of the UCCs. However, the variety of operating and business models implemented in these schemes makes it difficult to draw direct comparisons. Therefore, this study will focus on providing a general framework for the basic UCC services that can then be used in a wider context.

2. Identification of the costs and revenues linked to urban consolidation centre operations

In order to study the financial viability of the UCC schemes, we have identified and characterized the revenue and the cost elements linked to their operation according to the following categories: (1) UCC revenues; (2) infrastructure cost; (3) vehicle cost; (4) human resources cost; (5) equipment costs; (6) overhead costs. These categories will be addressed one by one in the next sections. Table 1 presents the notations used in the model.

Table 1
Notations used in the model.

R	Annual UCC revenues [€]	n_c	Avg. number of customers served daily [–]
C_{tot}	Annual total UCC cost [€]	r	Avg. distance between customers and the depot [km]
C_i	Annual UCC infrastructure costs [€]	Q_c	Vehicle capacity [customers]
C_v	Annual UCC vehicles cost [€]	Q_p	Vehicle capacity [parcel equivalents]
C_h	Annual UCC human resources cost [€]	n_r	Avg. daily number of the delivery routes [–]
C_e	Annual UCC equipment costs [€]	d_r	Avg. length of the delivery [km]
C_o	Annual UCC overhead costs [€]	t_r	Avg. duration of the delivery route [h]
C_{trans}	Annual UCC cost for transshipment operations [€]	t_s	Avg. duration of the delivery at customers' location [h]
C_{dist}	Annual UCC cost for the distribution operations [€]	t_u	Avg. duration of the loading at the UCC vehicles [h]
C_{gen}	Annual UCC cost for general expenses [€]	t_d	Avg. daily driving hours for UCC drivers [h]
$n_{parcels}$	Daily throughput [parcels]	$t_{d,tot}$	Avg. daily number of working hours for UCC drivers [h]
$n_{pallets}$	Daily throughput [pallets]	λ	Percentage of driving time for drivers [%]
n_{peq}	Daily throughput [parcel equivalents]	v	Avg. speed of the UCC vehicles [km/h]
$e_{parcels}$	Service price per parcel [€/parcel]	h_c	Avg. daily number of opening hours for the UCC [h]
$e_{pallets}$	Service price per pallet [€/pallet]	A	Surface of the distribution area [km ²]
e_{peq}	Service price per parcel equivalent [€/parcel equivalent]	s_d	Annual salary cost of UCC drivers [€]
ϕ_c	Number of operational days per year for the UCC	s_o	Annual salary cost of UCC operational and clerical staff [€]
ϕ_v	Number of operational days per year for the UCC vehicles	s_m	Annual salary cost of UCC managers [€]
ϕ_h	Number of working days per year for the UCC staff	n_d	Number of UCC drivers [–]
S	Total UCC surface [m ²]	n_o	Number of UCC operational and clerical staff [–]
c_v	Variable vehicle costs [€/km]	n_m	Number of UCC managers [–]
f_v	Fixed annual cost per vehicle [€]	n_f	Number of UCC forklift trucks [–]
n_v	Number of UCC vehicles	n_p	Number of UCC electric pallet jacks [–]
$d_{d,euct}$	Avg. daily Euclidian distance travelled by all vehicles [km]	c_f	Annual lease cost of a forklift truck [€]
d_d	Avg. daily driving distance travelled by all vehicles [km]	c_p	Annual lease cost of an electric pallet jack [€]

2.1. Urban consolidation centre revenues

We have collected information with regards to the pricing of the UCC services from several studies and implementation cases (Table 2). The prices were adjusted to reflect the evolution of the costs and prices of the goods transport over the years using the cost index of regional trucks (cf. Annex 1: Cost indexes), which takes into account elements such as fuel prices and salary indexes and is published every month by the French National Road Committee, a national economic observatory of the road freight transport (CNR, 2016a, 2016b). Results show that: (1) the most common way of charging for the UCC services is a fixed price per parcel, although some UCCs charge per weight (Monaco) or per delivery (La Petite Reine); (2) although the price of UCC services depends on numerous factors such as its location or type of service, an average price per pallet $e_{pallets}$ falls within a range of 2.50€–5.00€. This price range is also inline with the pricing of other delivery services, as highlighted by (Chiron-Augereau, 2009). Three more recent interviews with UCC operators in Brussels, Padova and La Rochelle (Lovens, 2016; Pandolfo, 2015; Renaudin, 2014) have confirmed this price range. Moreover, a price range of 10€ to 20€ per pallet was also estimated through these interviews, indicating that the average price for pallets is four times higher than for parcels (i.e. $e_{pallets} = 4e_{parcels}$). The UCC revenues (R) can therefore be expressed as a function of its throughput $R = \phi_c(e_{parcels}n_{parcels} + e_{pallets}n_{pallets})$ where $n_{parcels}$ and $n_{pallets}$ present the daily throughput in number of parcels and pallets respectively and ϕ_c the number of UCC operational days per year. In order to simplify the expression, we can define $n_{peq} = n_{parcels} + n_{pallets}/4$ which presents the daily throughput in parcels equivalents, leading an expression of the total UCC revenues in Eq. (1):

$$R = \phi_c e_{peq} n_{peq} \quad (1)$$

2.2. Infrastructure costs

For infrastructure costs, we have considered a lease arrangement rather than a building of a new infrastructure. Indeed, several authors (Allen et al., 2012; Verlinde et al., 2012) highlight the necessity of keeping the investments low, suggest using limited infrastructure or setting-up consolidation centres based on the existing transshipment centres. With this in mind, the total cost of infrastructure, C_i , can be

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