# "A State-of-Practice Review of Urban Consolidation Centers: Practical Insights and Future Challenges"

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**Abstract**

Urban Consolidation Centers (UCCs) constitute an appealing solution to urban freight distribution that ensures environmental friendly and cost efficient distribution in densely populated areas. Existing relevant research has placed the emphasis on the analysis of the underlying characteristics, services and operational advantages of UCCs, with limited focus on key determinants of long-term viability of UCC initiatives. The objective of this paper is to provide a comprehensive state-of-practice review of UCCs in Europe. The research capitalizes on positive and negative experiences and practices so that it comes up with key success factors and viability drivers, common sources of failure, as well as key determinants for the successful operation and management of UCCs. A hybrid approach combining Systematic Literature Review (SLR) methodology with multiple case study research was adopted. Our analysis highlights specific strategic, tactical, and operational factors that directly affect the successful operation and viability of a UCC.

**Keywords**: urban consolidation centers, transport pooling, urban freight distribution, last mile logistics, sustainable freight transportation

## 1. Introduction

Urban freight transportation has been rapidly growing in the last decades mainly due to increasing urbanization rates and the explosion of e-commerce. Traffic congestion, greenhouse gas emissions, noise, air pollution and accident fatalities constitute critical external impacts of the urban distribution system (Zissis et al., 2018). Various solutions and measures have been proposed and applied with view to improving city logistics. Policy-driven initiatives may involve road pricing (e.g., London), vehicle restrictions and load factor controls or low emission zones (e.g., Copenhagen). Private sector initiatives include carrier cooperation for consolidation and full-truck load deliveries, vehicle routing improvements and technological vehicle innovations (e.g., electric tricycles). Another appealing city logistics, infrastructure-driven solution involves the establishment of a specialized type of facilities with support from the public and/or private sector. These facilities are usually called Urban Consolidation Centers (UCCs) and aim to consolidate and enhance freight distribution operations in densely populated urban areas (Taniguchi and Thomson, 2018).

The term "Urban Consolidation Center" (UCC) has received rather vague and ambiguous definitions in the past. A lot of alternative terms have been used to describe this concept (e.g., public distribution depot, urban transshipment center, freight platform, retail/construction consolidation center, urban distribution/freight center, pick-up and drop-off location) (Huschebeck and Allen, 2005; Teo et al., 2015). The interpretation of the term gradually evolved such that in the '90s, the urge for consolidation operations shifted the focus on managing full load deliveries (Browne et al., 2005). A broadly accepted definition that is also adopted by the authors contemplates that a UCC is a logistics facility that serves a city center, a whole town or a specific site (e.g., shopping center). At this facility, which is located near the area served, consolidation operations take place, and then deliveries are executed with environmental friendly vehicles for the last-mile journey to the drop-off point. On top of sorting and consolidation, other value-added services are also offered such as product labelling, reverse logistics, temporary storage and specialized services (Allen et al., 2012; Teo et al., 2015).

The first UCCs were introduced back in 1940 in the United States but closed after some years mainly due to lack of relevant expertise. Nowadays, UCCs have spread worldwide, including Europe and Asia. Despite the long evolution process and the large number of UCCs ventures all around the world, their initial establishment and mostly their long-term sustainability has been a significant challenge. Most of about 200 UCCs initiated in Germany are now closed (Allen et al., 2012). Despite the increasing popularity of UCCs, there is not much relevant research published in academic journals, with the existing body of knowledge being recently consolidated by Lagorio et al. (2016) and Björklund and Johansson (2018). Existing relevant research has mostly addressed optimal design structures and operational aspects of UCCs along with the role of stakeholders (Browne et al., 2011; Nordtømme et al.,

2015). Furthermore, there are relevant contributions addressing the role of UCCs and the controversial issue of their financial viability and operational sustainability (Triantafyllou et al., 2014; Björklund and Johansson, 2018). However, most of the critical factors and relevant research findings pertaining to the longevity of the UCC initiatives have been drawn from evidence on a single UCC case or a circumscribed set of case studies (Nordtømme et al., 2015; Björklund et al., 2017; Akgün et al., 2020). In our paper, we aim to provide a comprehensive state-of-practice review of UCC ventures either in service or having terminated their operation (i.e., closed) at the time of writing. The main goal of our research is twofold: i) to identify critical determinants and influential factors affecting the management and operation of UCCs and ii) to provide a mapping of the current state of affairs in terms of UCC ventures (operating or closed) in Europe. A subsequent objective of our analysis is to capitalize on relevant, positive or negative, experience in order to come up with key success factors and viability drivers, common sources of failure, as well as key challenges in the design, operation and management of UCCs. In doing so, we will follow a hybrid methodological approach, combining both literature review and primary desk-based research (i.e., multiple case study analysis) among open/closed UCCs. The remainder of this paper is structured into five sections. Section 2 presents the overall methodological approach and research scoping issues. Section 3 discusses in a structured way the critical factors addressed in existing literature with respect to the design, operation and management of UCCs. Section 4 presents a current state-of-practice review of UCCs in Europe and highlights common success and failure factors stemming from the analysis of UCC cases. Section 5 summarizes the practical insights and key challenges for successful design, operation and management of UCCs, while Section 6 presents the concluding remarks of the paper.

## 2. Overall Methodological Approach

The aforementioned research objectives were fulfilled by a hybrid methodological approach combining Systematic Literature Review (SLR) (Jesson et al., 2011) and multiple case study research (Eisenhardt, 1989; Yin, 2013) (Figure 1).

The literature review part of the analysis (left stream of research in Figure 1) aimed to identify and discuss the critical factors affecting the sustainability of UCC operations. In that respect, we initially conducted a Systematic Literature Review (SLR) with the aim to develop a thorough understanding of those key determinants in the form of success factors and viability drivers, common sources of failure, as well as key challenges in the design, operation and management of UCCs. It is worth noting here that this was meant to be a focused SLR process explicitly targeting on the identification of critical (success/failure) factors rather than a full-scale literature review and categorization of future research about UCCs, already offered by Björklund and Johansson (2018). Our literature search covered published academic research articles between 2000 and 2020 in Web of Science and Scopus. The search process was conducted by means of three research strings, separated by the respective Boolean operators as follows: “urban consolidation centers” AND “success factors” OR “failure factors”. A number of inclusion criteria (e.g., peer-reviewed articles, published after 2000, available full-original text in English) were then applied. The search has gradually evolved from titles to abstracts, keywords and full text.

The initial search results contained 484 sources in Web of Science and 17 sources in Scopus. Following relevance screening based on subject areas and titles, 167 articles from Web of Science and 5 articles from Scopus were excluded. Another 301 articles in Web of Science and 5 articles in Scopus were removed from consideration based on abstract and keyword screening, thus narrowing down the resulting sources to 23 closely relevant articles. A snowball approach (12 articles) for the most relevant sources complemented by a manual review (22 articles) resulted in additional 34 articles of potential interest. Overall, the retained core list of literature sources included 57 peer-reviewed journal articles, most of which are organized around broad categories of critical factors for UCCs and discussed in Section 3. The retained literature base contains articles published in the broader subject area of transportation, logistics and supply chain management, with an increasing research activity particularly concentrated during the first half of the decade (2011-2016) (Figure 2).

The literature review part of our analysis has been complemented by a state-of-practice review conducted through a multiple case study research approach (Eisenhardt, 1989; Yin, 2013) (right stream of research in Figure 1). In that respect, we aimed to provide a mapping of UCC ventures, while simultaneously collecting relevant, positive or negative, experiences that might be useful in validating the critical success/failure factors stemming from the literature review process. We employed a multiple, cross-case analysis approach with view to maximizing the repository of relevant experiences. Both currently operating and closed UCCs in Europe were selected as the targeted analysis cases. Although we attempted to form the widest possible and most representative (in terms of country origin) set of UCC cases, the examined UCCs should by no means considered an exhaustive list of all known UCC initiatives brought forward in Europe. One of the problems we encountered during our research was the fact that certain UCC implementations (particularly of already closed UCCs) were not disseminated into relevant scientific/technical fora and/or had no longer active project websites. Therefore, we aimed to collect relevant UCC-specific data through multiple sources extending beyond the SLR academic (journal) literature base. For the purposes of the state-of-practice review, we also examined various industry sources (e.g., technical reports, case studies), project deliverables/handbooks with particular emphasis placed on EU-funded projects dealing with UCC implementations (e.g., BESTFACT, BESTUFS I/II, CITYLOG, GrowSmarter, LaMiLo, NOVELOG, SUCCESS, U-TURN) and desk-based research, including websites of international associations/organizations representing the collective interests of the specific logistics sub-sector (e.g., Eltis Urban Mobility Observatory, Green Freight Europe Initiative, International Road Transport Union, eco2city).

It should be also stressed here that we did neither aim to assess nor designate UCC initiatives as successful or failure cases. Instead, we aimed to potentially come up with critical factors and key challenges that might have been experienced by either operating or closed UCCs. At the same line of reasoning, special project UCCs (e.g., Construction Consolidation Centers – CCCs) constitute a discrete category on the grounds that they are, by design, short-lived projects. As a result, their possible categorization under "closed" UCCs indicates only their current operating status and should, by no means, be interpreted as a project failure. On the other hand, CCCs, either active or not, may also shed useful light onto relevant critical factors and challenges. Finally, evidence from literature review with the state-of-practice review

has been synthesized to form practical insights and recommendations at strategic, tactical, and operational level.

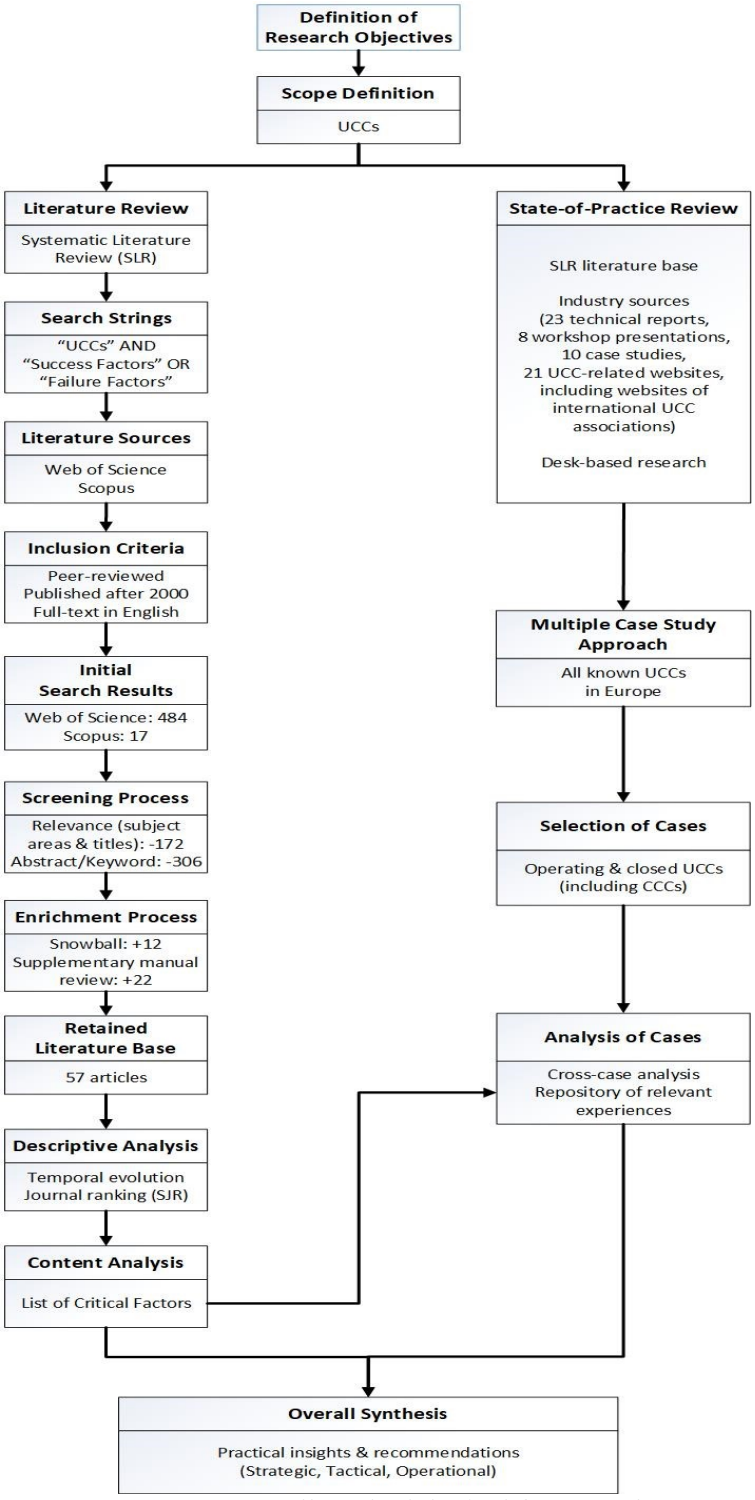


**Figure 1**: Overall methodological framework

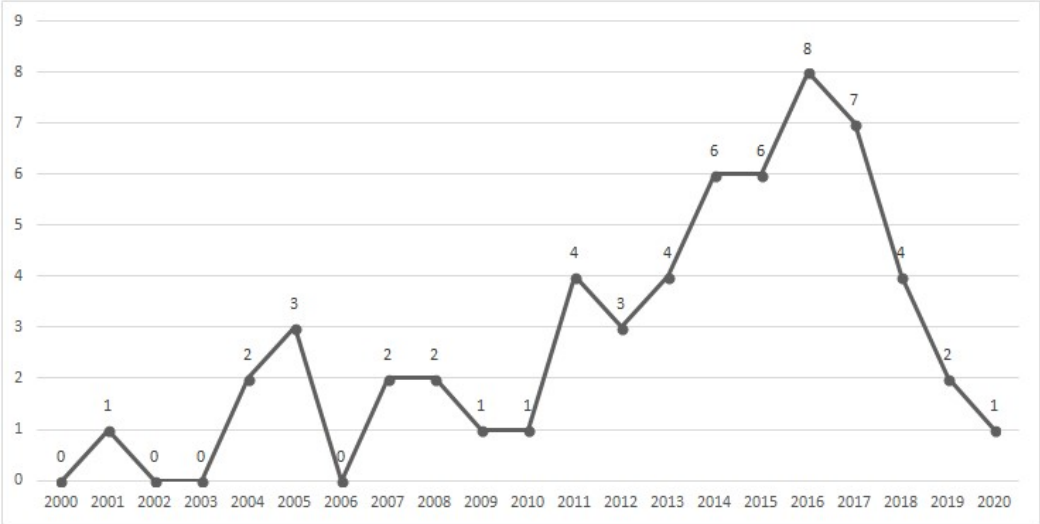


**Figure 2**: Temporal evolution of relevant research

## 3. Identification of Critical Factors

The key factors considered of critical importance in existing relevant research are summarized in Table 1 and further discussed in the sub-sections that follow.

**TABLE 1 SHOULD BE INSERTED HERE**

### 3.1 Operational type

Many different classification schemes of UCCs have appeared in relevant literature (Browne et al., 2005). Some of the proposed classifications were based on relevant experience of specific countries or existing UCCs (Köhler, 2001; Klaus, 2005). BESTUFS (2002) distinguished between freight platforms at urban, regional, national and international level and specified three types of freight platforms at the urban scale: i) single-company UCCs, ii) multi-company UCCs and iii) freight villages. In our paper, we adopted the broadly established classification scheme provided by BESTUFS II (2007), which elaborates on the BESTUFS (2002) classification and fits with the definition of UCC adopted for our research purposes. It essentially introduces a more generic scheme categorizing UCCs based on their intended use, type of service, and geographical area served (Huschebeck and Allen, 2005). Three main operational types/categories of UCC are identified:

- **Special Project UCCs:** Facilities that serve a single-site for specific, non-retail purposes. These are typically used for the purposes of construction projects with the aim to consolidate, store and handle construction materials. They operate for a given time period and they could fit over any given geographical scale of the urban area. Typical examples are the construction material UCC in Heathrow and in Stockholm (Janjevic, 2015).
- **UCCs on single-sites with one landlord:** These UCCs serve retail purposes but differ from others in the following: i) as they serve a single site, their design may be also part of the broader design of the whole project, ii) the landlord has the right to demand the execution of deliveries only through the UCC, iii) there are usually pre-defined, off-street unloading points, which are accessed by single routes, and iv) rent structures and handling charges essentially contribute in the

financial independence of the UCC. Typical examples of this category of UCCs are those situated at airports and large shopping centers (e.g., Heathrow retail UCC, Meadowhall UCC).

- **UCCs serving a town/city:** These UCCs are also used for retail purposes. They vary with the geographic area covered, from city center to entire city, and the number of companies they serve. Indicative examples of such UCCs are those of La Rochelle, Bristol etc.

### 3.2 Type of public involvement

A major differentiating factor among UCCs pertains to the type and degree of public involvement or intervention. Governments generally seem to be supportive since their main interests are aligned with the underlying motivation behind UCC establishment such as the reduction of congestion, emissions, noise pollution and road accidents (Björklund and Johansson, 2018; Nocera et al., 2020). Certainly, the more the involvement of governments in UCC initiatives, the stronger the support offered to UCC operations (BESTUFS II, 2007). Governments may play either a deterministic role (e.g., Monaco, Leiden-Netherlands) by forcing the use of UCC or demonstrating lower leading initiative (e.g., Kassel), where the operation depends mainly on the voluntary cooperation of the participants. In any case, a mutual involvement of both public and private sector renders the initiative more attractive for private sector (BESTUFS II, 2007; Lebeau et al., 2017).

It is commonly observed that a strong public sector regulatory mandate is rather helpful for the broad acceptance and intensive use of the UCC scheme (Morganti and Gonzalez-Feliu, 2015; Fahrenkamp, 2016; Holguín-Veras et al., 2018; Akgün et al., 2019). As a matter of fact, one of the most crucial factors preventing UCCs from becoming self-sustainable is that many carriers and shippers insist in delivering goods on their own. Being unable to ban the autonomous delivery of goods, local public authorities may provide regulatory support by exercising access restriction measures promoting the intensive or even catholic use of UCCs (Akgün et al., 2020). These restrictions can have the form of delivery time windows, as well as vehicle weight, size, speed or type (e.g., low emission vehicles) limits or zone-based access fees and parking restrictions, with favorable treatment of UCC vehicles/users (Marcucci and Danielis, 2008; Quak, 2008; Quak and de Koster, 2009; Quak and Tavasszy, 2011; Ville et al., 2013; Estrada and Roca-Riu, 2017; Elbert and Friedrich, 2018). Last but not least, regulatory provisions imposing access restrictions near historical centers have been proven quite supportive for UCC operations (Quak, 2008).

### 3.3 Financing support

A commonly cited determinant of the long-term, financial sustainability of UCC initiatives is the level of financial support obtained especially from public institutions and (local) authorities. Although a common expectation is the medium/long-term self-financing of such initiatives, these are rarely viable without public support in the very early stages of initiation of the venture (BESTFACT, 2015; Akgün et al., 2019). Most projects receive public subsidies either from the government, local authorities or the European Union, at least for the early beginning of the UCC establishment (Panero et al., 2011; Allen et al., 2014). In other cases, the Public-Private-Partnership (PPP) model is adopted for the establishment and operation of a UCC (BESTUFS II, 2007).

Except for the coverage of the early set-up and operational costs, such subsidies allow the UCCs to offer attractive prices even with fewer participants (Battaia et al., 2014). As a matter of fact, they cover the UCC's usage fees and equal the challenging costs and gains for the carriers (Akgün et al., 2019). However, the limited duration of such supporting measures entails high risks due to possible incapacity of UCC schemes to become economically independent once subsidies terminate (Duin et al., 2010; Gonzalez-Feliu et al., 2014; Kin et al., 2016; Lagorio et al., 2016; Holguín-Veras et al., 2018; Johansson, 2018; Van Heeswijk et al., 2019). As a matter of fact, some UCCs may not succeed to gain enough revenue themselves (Johansson, 2020) besides the delivery and value-added service fees (Van Duin et al., 2016; Janjevic and Ndiaye, 2017).

### 3.4 Ownership, management scheme and operating business model

Another important characteristic pertains to the type of ownership of the UCC, the underlying business model for the management and operation of the UCC, as well as the allocation of delivery costs and benefits/profits to engaged stakeholders. The following ownership schemes and operating business models are usually encountered in practice (Browne et al., 2005):

- **UCC privately owned and operated by a single party, either directly or by subcontracting:** three cases appear in practice: i) single-site with one landlord, where retailers are benefited from special handling for using the UCC (e.g., shopping mall-UCC in York), ii) single-site "demanding" landlord, where the retailers are required to use a common UCC (e.g., Stockholm and Heathrow construction UCC) and iii) "Dutch System", where carriers and shippers are kind of obliged to use the UCC.
- **Private joint ventures, led by the carrier industry without involvement of any public institution:** this category refers to carriers who have to cooperate to run a UCC, as they cannot afford to act individually. They tend to look for neutral solutions, like starting up a joint company (e.g., Kassel UCC).
- **Private Public Partnerships (PPP):** the establishment of a UCC whose owners derive from both private and public sector. Stakeholders could be local authorities, commercial actors, logistics operators etc. This kind of ownership is extensively used in Italy (Browne et al., 2005), and may appear in two forms, either the start-up of a new company (e.g., Siena) or the establishment of agreement with an existing one (e.g., Padova).
- **Publicly owned UCC:** these are initiatives owned by public authorities and operated by private actors selected by tender (e.g., La Rochelle).

Akgün et al. (2019) stress collaboration among stakeholders as one of the greatest challenges. Regardless of the type of operating business model, it is widely recognized that it is essential to pursue the active involvement and early engagement of all stakeholders with special emphasis placed on carriers and shippers (Browne et al., 2005; Allen et al., 2012; Gonzalez-Feliu et al., 2014; Nordtømme et al., 2015; Osterle et al., 2015; Björklund et al, 2017), as their business model is mostly changed (Akgün et al., 2019). Bottom-up initiatives that include early involvement of carriers and shippers tends to bring more successful results concerning the viability of the UCC project (Quak, 2008). In that respect, many researchers stressed the importance of early establishing a solid coordination mechanism among stakeholders in order to

trigger some "critical" demand that will ensure the viability of the UCC initiative (Gonzalez-Feliu et al., 2014; Van Duin et al., 2016). The latter seems to be more easily achieved in cases with a single landlord responsible to monitor and finance the scheme, while in multi-users UCCs problems of cost and benefit allocation arise (Browne et al., 2011; Zhou and Wang, 2013; Gonzalez-Feliu et al., 2014; Triantafyllou et al., 2014). Finally, the absence of clear gains and cost allocation mechanisms among stakeholders, along with the carriers' anxiety for bearing extra delivery or transshipment costs (Fahrenkamp, 2016; Van Heeswijk et al., 2019) render them cautious and unwilling to participate, hence jeopardizing the longevity of the initiative especially after the end of the start-up subsidy (Ambrosini et al., 2013; Dahlberg et al., 2018; Hezarkhani et al., 2019).

### 3.5 Fleet composition

The composition of UCC fleet plays a decisive role in delivering *inter alia* environmental benefits in the form of reduction of vehicle emissions, energy consumption and noise generation (Crainic, 2004; Dablanc, 2007; Lin et al., 2014; Triantafyllou et al., 2014; Gianessi et al., 2016). The operating fleet of UCCs typically includes clean vehicles using alternative fuels such as biofuels, natural gas, electricity or hybrid technology. E-cargo bikes are very popular among UCCs, while many of them are also equipped with a larger vehicle (e.g., < 3.5 t. GVW) for bigger loads. Intermodal transport is also applicable in some cases (Kin et al., 2016). In addition to environmental benefits, other social and economic benefits such as less traffic nuisance and less costly distribution are quick-wins that should not be underestimated (Browne et al., 2007; Quak, 2008). UCCs' clean fleet compromises with the access restrictions, provides customer benefits, and contributes in the schemes viability (Quak and de Koster, 2009). Indicative performance metrics used for this purpose are the number of vehicle trips, number of vehicle kilometers, and number of vehicles (Browne et al., 2007; Gogas and Nathanail, 2017).

### 3.6 Service portfolio offered

Shipment consolidation (grouping) lies at the heart of a UCC operation as an attempt to reduce the number of daily shipments and vehicle itineraries to retail stores in cities (e.g., Kassel UCC). Another major functional property pertains to buffer stockholding and/or remote short-term storage and cross-docking for retailers (e.g., Siena, Malaga UCCs) (Browne et al., 2005). As a general rule, storage in UCCs is rather short-term with goods usually moving in less than 24 hours (Campbell et al., 2010). Order fulfillment and various pre-retailing activities (e.g., unpacking, labeling, kitting, security tagging) also constitute typical services offered by a UCC. On top of conventional consolidation, short-term storage and order fulfilment services, UCCs often demonstrate a broader service portfolio containing extra value-added services and reverse logistics (e.g., product returns, packaging re-use/recycling, waste management). Among the most common value-added services offered by a UCC, one can distinguish between inter-store transfers, e-fulfillment, home deliveries or last-mile delivery with environmental-friendly vehicles. Value-added services are normally charged at commercial rates and constitute important sources of revenue for the schemes (Campbell et al., 2010; Triantafyllou et al., 2014; Teo et al., 2015; Lebeau et al., 2017; Johansson, 2018). Besides, these services promote the attractiveness of the UCC, while simultaneously providing essential support for the UCC scheme to break even (Panero et al., 2011; Handoco et al., 2016; Johansson, 2020). Finally, value-added services improve users' perceptions about the UCC and

increase the users' willingness to pay for such services (Van Heeswijk et al., 2019), provided, however, that the scheme is accepted (Akgün et al., 2019). The most common services offered by UCCs are summarized in Table 2.

**TABLE 2 SHOULD BE INSERTED HERE**

### 3.7 Catchment area, location and distance from market served

The catchment area depends on whether the UCC serves a single-site or an entire or part of a city/town (Köhler and Groke, 2004). Obviously, the catchment area is also strongly related to the density of customers both within the city boundaries as well as in the broader city surroundings (Finnegan et al., 2005; Lin et al., 2014; Paddeu et al., 2017). The location of a UCC has clear implications on many aspects such as society and environment, local economy, safety and increase in local traffic (Quak and Hendriks, 2012; Rao et al. 2015). The ideal location for the establishment of a consolidation center should account for a combination of factors with the most important being the proper interurban distance travelled by big delivery vehicles, the accessibility of the UCC by conventional carrier vehicles, the type and capacity of environmental-friendly last mile delivery vehicles and the real estate costs of candidate sites (Huschebeck and Allen, 2005; Triantafyllou et al., 2014). In some cases, sites near the city center are considered more strategic locations (Duin et al., 2010), while simultaneously mitigating certain construction legislative restrictions. Moreover, UCCs located in central areas better deal with ground morphology peculiarities, capitalize on existing infrastructure, utilities etc. and enable the use of bicycles for last mile deliveries. On the other hand, real estate costs and the accessibility of the UCC by medium-big trucks have been underlined as critical location factors in other UCC implementations. In that respect, UCC locations outside central areas exhibit substantially lower real estate costs. Furthermore, the UCC location should also facilitate the upstream flows of products, hence ensuring easily accessible links to the national highway network (Battaia et al., 2014; Triantafyllou et al., 2014; Morganti and Gonzalez-Feliu, 2015). As a matter of fact, a UCC location outside the central city area would avoid serious access restrictions frequently enforced in historical city centers and would facilitate the upstream access of medium/big delivery vehicles to the UCC. At the outset, the optimal UCC location should be determined with view to minimizing distribution cost savings (Awasthi at al., 2011; Gonzalez-Feliu et al., 2014; Sopha et al., 2016), while simultaneously ensuring both upstream and downstream accessibility (Janjevic, 2013).

### 3.8 Size

The size of a UCC is strongly affected by several factors with the most important being the volume of product flows (Browne et al., 2005), the density of customers served (Finnegan et al., 2005; Lin et al., 2014; Paddeu et al., 2017) and the nature of value-added services offered (Triantafyllou et al., 2014; Janjevic, 2015). It is clear that high volumes of product flows and high density of customers enable economies of scale that accelerate the payback of a UCC start-up investment cost. In fact, the density of interest points (e.g., retailers, customers to be served), rather than the size of the catchment/service area, has been recognized by many researchers as a critical success factor for the UCC viability (Finnegan et al., 2005; Lin et al., 2014; Paddeu et al., 2017). Moreover, the value-added service mix offered may also influence the size of a UCC on the grounds that a UCC dedicated, for example, to regular/buffer

stockholding, will demand higher space requirements compared to a UCC offering micro-consolidation and cross-docking services (Triantafyllou et al., 2014; Janjevic, 2015). Here, it is also worth noting that the size/surface of a UCC significantly affects its development and operating costs and subsequently the critical volume of transactions required to break-even. The amount of capital and operating costs of a UCC facility (e.g., land purchase, building costs/rental costs, personnel, utilities, insurance, security) clearly represent a setback to the project's economic development and viability (Campbell et al., 2010). Some researchers suggest as a rule-of-thumb that the proper size/surface of a UCC provides for $10m^2$ for each retail outlet served (Lewis et al., 2007). However, this formula/specification can only be viewed as an upper bound in that it assumes 100% distribution of all retail products through the UCC (Lewis et al., 2007). Accounting for the influential role of UCC size on costs, some UCC initiatives, with the most prominent being the successful Barcelona's UCC, opted for small, "low-cost" facilities with a limited service portfolio in order to reduce the investment needed and the operating cost to run the service. Along the same direction, other similar initiatives such as the establishment of micro-consolidation centers or Urban Staging Areas (UsA) in several cities (e.g., Bordeaux, Rouen, La Rochelle, Monaco) (Roche-Cerasi, 2012; CIVITAS WIKI, 2015) keep the start-up investment and the operating costs at low levels so that the required volume of transactions to break-even can be reasonably achieved. In any case, no matter what the initial size of the UCC is, the expansion potential in terms of both scope and scale needs to be taken into consideration (Triantafyllou et al., 2014; Janjevic, 2015).

## 4. Current State of Practice in Europe

This section presents an overview of the current state of practice in terms of existing, currently operational UCCs (Section 4.1), as well as other UCC ventures that have terminated their operation (Section 4.2) (both UCC cases examined are located in Europe). Relevant information pertains to the critical factors affecting UCC viability (as identified in Section 3) and has been extracted through an integrated approach combining both academic literature review sources and desk-based research (please refer to Section 3).

Overall, we came up with a list of 82 UCCs in 17 European countries as the primary objects of our analysis (Figure 3); 62 UCCs are open and still operational in 2019, of which only one is a Construction Consolidation Center (CCC), 20 UCCs are closed, of which 13 UCCs have terminated their operation because of, *inter alia*, financial reasons, and 7 UCCs were terminated as they completed their purpose as CCCs. As it can be observed in Figure 3, most of the UCCs having terminated their operation were in Italy, France, the United Kingdom and Germany, respectively. On the other hand, these countries have invested a lot in research and actively promoted the development of UCCs, a fact that can be also verified by the large number of successful UCCs located at these countries. In particular, 4 UCCs in Italy have terminated their operations with another 12 UCCs being still active. Similarly, there are 11 currently open UCCs in France and 5 having terminated operations. Moreover, a significant number of new UCCs are about to open in countries like Poland, Spain, Norway and the Netherlands.

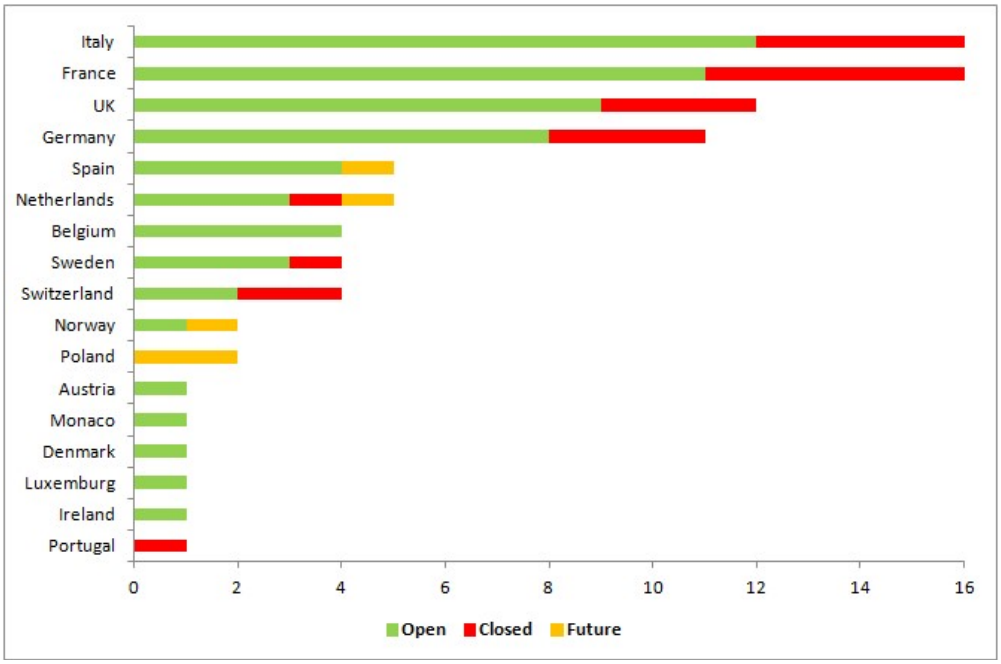


**Figure 3**: Overview of open, closed and future UCCs in Europe (by country)

### 4.1 Currently operational UCCs

The history of UCCs in Europe dates back in the '90s, when 13 UCC projects were launched and kept actively going in the 21st century. Another 24 UCCs initiated operations in the '00s, with the rest launched in the last decade. In 2019, 62 UCCs were still open and actively operational in serving their associated urban areas. All 62 UCCs were examined with view to identifying key determinants of their viability.

Regarding the UCC classification by type of coverage, more than two thirds of the examined UCCs serve the retail needs of a town/city. The establishment of a UCC is most likely to flourish in city centers or boroughs, where the streets are narrow and there are historic layouts. Such places suffer from serious traffic congestion problems, parking difficulties, restricted (time) access, frequent pedestrian areas and highly observed pollution levels (Björklund and Johansson, 2018), all factors rendering the UCC establishment more attractive. The use of transition depots (UCCs) and vehicles of pre-defined technical specifications aim to control the traffic and the resulted gas emissions. UCCs that serve a single site with one landlord tend also to be successful, as all of them are sustainable for almost two decades, and most of them are indeed self-financed (e.g. in Heathrow airport, in Sheffield, and in York).

The majority of UCCs that remain sustainable and economically viable are privately owned (approximately 60%), while all types of private ownership and operation are met (e.g., single site with one landlord, "Dutch system", neutral company). It is of great importance to mention the contribution of the private sector's expertise for the success of the schemes, as in many cases experienced carriers in logistics procedures are selected to operate the UCCs (e.g., DHL in HAL and Bristol, Clipper Group in Sheffield and Essex). Furthermore, one third of the existing UCC initiatives were resulted by cooperation schemes among private and public actors (17 schemes). The

latter usually represent successful cases, as requirements, expertise and resources from both sides are put together to ensure more economically viable outcomes. The economic interests of the carriers and the environmental and social interests of the public sector are enforced, while the public regulatory mandate as well as the financial support are more possible to be ensured (e.g., Utrecht, Veloce, Malaga) (Gonzalez-Feliu et al., 2014; Van Duin et al., 2016). The operation of the platform is in most cases carried out by neutral private companies such as big transport operators or third-party logistics service providers, which have been either *ad hoc* start-up companies (e.g., UCCs in Barcelona, Frankfurt) or other existing companies often selected out of a bidding process (e.g., UCCs in La Rochelle, Kassel).

However, the establishment of a UCC constitutes a very costly investment that may not reap its fruits without some - at least initial - public financial and regulatory support. This support may come in different ways; 65% of the existing schemes received partial or whole public funding. For instance, public authorities used to give subsidies to Binnenstadservice UCC in Nijmegen during the initialization period, which were gradually reduced during the next years (Duin et al., 2010; Browne et al., 2005). Besides direct subsidies, authorities may also contribute in the UCC profitability with the upgrade of the fleet with environmental friendly vehicles and the free or discounted provision of public infrastructure (e.g. The Green Link, Malaga, La Petit Reine) (Lamilo, 2015, Browne et al., 2005, Bestfact., 2014, Duin er al., 2010). The regulation of the access of freight vehicles (based on weight restrictions) to the area served by the UCC due to ground morphology (e.g., Monaco) constitutes an example of public regulatory support that positively enhances the UCC operations.

The greatest challenge for a UCC is to ensure its sustainability over the years. In doing so, the UCC should promote smooth cooperation among stakeholders, while simultaneously ensuring its financial viability (Van Duin et al., 2016). Actors involved in the scheme need to feel that they are actively benefited by the use of the UCC without substantial compromises (Van Duin et al., 2016). A main prerequisite is the establishment of a proper organizational structure and its associated business model. From an economic point of view, revenues must be at least sufficient to cover operational and other costs of the UCC. The income of a UCC is defined primarily by the revenue streams, and secondarily by the provision of key resources or assets (Van Duin et al., 2016). Different types of revenue streams can be determined. Public authorities may provide full or partial subsidies to the UCC (e.g., provision of 45% partial subsidy of operational costs in Bristol by the City Council, 22% partial public subsidy in Padova) (Panero et al., 2011). Logistics users can generate revenue streams for the UCC as well. This depends on the pricing scheme and structures adopted by the UCC. The most common type is through the usage fees. Usage fees are usually determined as a fixed price per parcel, but it may also be charged as a fee per weight (e.g., Monaco), or price per delivery (e.g., La Petite Reine) (Janjevic and Ndiaye, 2017). Some of the factors affecting the charging price are the location of the UCC and the type of services provided. In all cases, the price usually falls within a range of 2,50-5,00€/parcel (e.g., Brussels, Padova) (Janjevic and Ndiaye, 2017). The estimated charges per pallet are four times higher and range between 10 and 20€ (e.g., 14€/pallet in Bristol) (Van Duin et al., 2016; Janjevic and Ndiaye, 2017). Other

revenue types may originate from membership subscription (e.g., 30-50€/month in Nijmegen) or delivery costs depending on average delivery stops per week per retailer (e.g., 9-12€/week per retailer in Nijmegen) (Van Duin et al., 2016). Important source of revenue are also the value-added services (Campbell et al., 2010)

One of the primary motivating factors behind the establishment of a UCC is the potential reduction of environmental impacts (Björklund and Johansson, 2018). In that respect, UCCs often equip their fleet with vehicles that consume environmental-friendly energy. In Europe, the most popular type of fleet consists of electrically-assisted vans or (tri)cycles (in 36 out of 62 UCCs), while diesel vans are also an often case (30 out of 62 UCCs) mainly due to their high capacity being able to carry more load. Combination of both types of vehicles serves all kind of needs, while prevents costly and extra damaging routes. Intermodal transport is also applicable in some cases, such as water-road transportation in Antwerp (Kin et al., 2016) and rail-road transportation in Graz (Schrampf, 2005).

In better controlling these parameters, the selection of the UCC location and the underlying distance from the area served is of utmost importance. Less than 1 km from the area served is generally considered a small distance, 1-6 km is a medium distance and over 6 km is a considerably large distance for a UCC aiming to serve the needs of a town/city (CPAS, 2010; Roche-Cerasi, 2012). The huge majority of operational UCCs are in medium or small distance from the area served (e.g. Nijgemen, The Green Link, Gothenburg), a fact that confirms that locations near the area served tend to be more strategic (Duin et al., 2010). In big cities like Paris, the UCCs are placed even inner the city in order to serve the needs of a specific densely populated area, while in other cases like Brescia, the UCC is placed relatively far away (5.6 km), probably by exploiting the operational advantage stemming from the use of clean vehicles.

Last but not least, the surface occupied by a center may vary depending on the market's emerging needs. A UCC that covers less than 350 $m^2$ is considered small, mid-sized for less than 1.500 $m^2$, with large UCCs covering usually an area more than 1.500 $m^2$ (Figure 4) (Janjevic, 2015; LaMiLo, 2015). In Europe, almost one third of open UCCs belong to the small or mid-sized category, with almost half of the examined UCCs being large facilities (over 1.500 $m^2$). Large UCCs can facilitate more value-added services and offer more chances for extra revenue and economic development (e.g., Diena, Parma, and Sheffield offer great variety of VAS) (Triantafyllou et al., 2014; Janjevic, 2015). The smallest one is located in Barcelona (150 $m^2$), Brescia (400 $m^2$) and Paris, Chronopost (1.000 $m^2$). The biggest case (45.000 $m^2$) appears also in Paris ("La Chapelle"). Usually, when it comes to central areas (e.g., capital city), the emerging needs of the market are more intensive, while the product flows and the density of customers are higher, which makes it easier to achieve economies of scale (e.g., Dublin, Paris, Luxemburg, Zurich) (Finnegan et al., 2005; Lin et al., 2014; Paddeu et al., 2017). Hence, it is observed that the density of the delivery points in large/capital cities often results in bigger surface area of the corresponding UCCs. Figure 4 illustrates the distribution of operating UCCs in

Europe according to their surface area. Unfortunately, there was no available information about all examined UCCs (i.e., 12 UCCs of unknown size/surface areas).

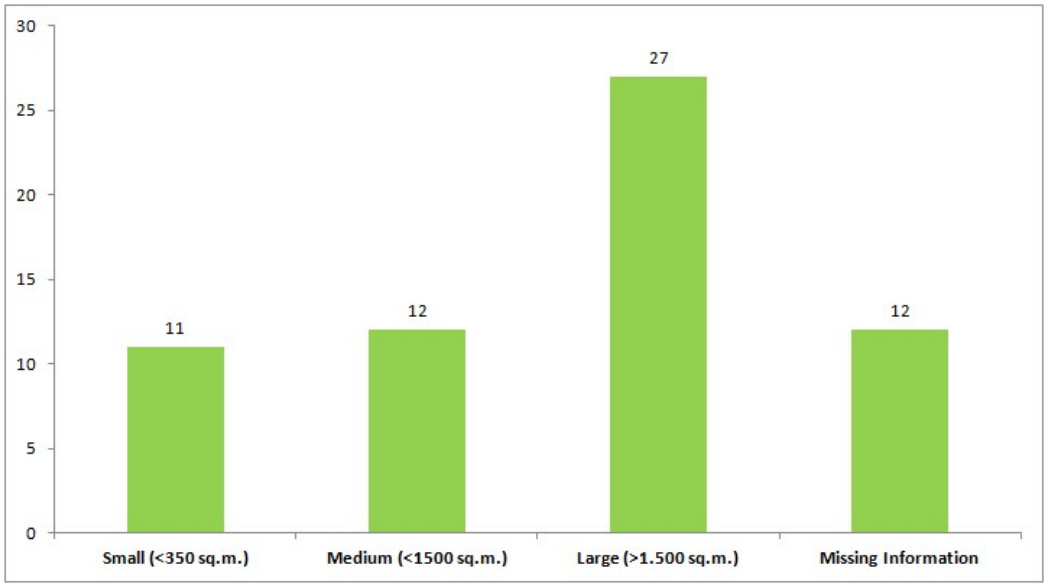


**Figure 4**: UCC classification in Europe (by surface area)

The establishment of a UCC normally produces substantial benefits for urban areas usually suffering from excessive, harmful gas emissions. All open UCCs have reported notable reductions in pollutant emissions, and particularly in $CO_2$, $NO_X$ etc., ranging from 25% (e.g., Monaco) (Ruesch, 2004) to over 35% (e.g., Bristol) (Rees and Gahan, 2011). At the same time, all of them have reported important reduction in air and noise pollution levels. Another common benefit comes through the reduction in the number of vehicles entering the city (up to 75% in Bristol), the total distance travelled as well as the reduction in public place used for trucks and vans (e.g., Barcelona) (Rees and Gahan, 2011; GrowSmarter, 2019). In Stockholm, the vehicle utilization rate has increased to 85% (Campbell et al., 2010). The volume of the recycled products has also increased, as one of the most common value-added services offered is the picking-up of packaging and waste (e.g. 23.000kg in HAL (Rees and Gahan, 2011). The reduction of traffic congestion has also led to other benefits, such as increased safety in the streets, and a cleaner atmosphere improving the inhabitants' quality of life. Last but not least, many UCCs users observed increased customer service and cost savings due to the consolidation of their incoming orders in high-volume deliveries (e.g., Kassel, The Green Link, San Sebastian) and the improved employee productivity due to consolidation of receipts from multiple suppliers (BESTFACT, 2015).

In what follows (Table 3), we summarize the key determinants and critical factors for existing (currently operational) UCCs in Europe as of 2019. In particular, the table provides an overview of the following types of information: i) UCC identification details (e.g., city, name, opening date, surface area/size), ii) UCC type (i.e., special project UCC, UCC on single-sites with one landlord, UCC serving a town/city), iii) type of public involvement and ownership (i.e., public, private, both), iv) management

scheme (e.g., public/private operator), v) financing support, vi) fleet composition in terms of fleet size and type of vehicles (e.g., electric vans, cargo bikes, tricycles, diesel vans, Clean Natural Gas/CNG vans), vii) distance from the area served and viii) services offered. As far as the type of facility is concerned, A stands for Special Project UCCs, B for UCCs on single-sites with one landlord, C for UCCs serving the urban area of a town/city, and finally C(Ctr) for UCCs serving the city center. PPP accounts for a joint Private-Public ownership/partnership, while P&P for receiving both private and public funding support. Finally, cells indicated with "-" correspond to missing information based on available literature and desktop research.

**TABLE 3 SHOULD BE INSERTED HERE**

### 4.2 Currently non-operational UCCs

Some of the UCC schemes did not manage to flourish or ensure their viability in the medium to long run. Figures 5 and 6 summarize those UCC initiatives that have terminated their operations, by reporting opening and closing years, as well as duration of operations, separately for closed UCCs and CCCs, respectively. As a matter of fact, there has been a substantial development of such projects in Europe after '90s, with most of these schemes launched after 1990, and then followed by a widespread adoption mainly after 2000. An exceptional case to that rule was the French experiment in Paris to run a UCC in 1969 for grouping-ungrouping operations. Sogaris, the operator, did not succeed to attract sufficient flows and faced low activity. The project stopped, but the facility is now part of a multi-logistics platform (Trentini et al., 2015).

Regarding the duration of the schemes, the logistics platform in Aachen demonstrates the longest duration of terminated UCC initiatives, namely 19 years (Browne et al., 2005) (Figure 5). Although the UCC in Aachen proved to be significantly resistant over time, it eventually did not manage to remain viable. A key to its temporary success was the involvement of the users early in the process, which brought its wide initial acceptance (Browne et al., 2005). Other UCCs with certain longevity are those in Frosinone (8 years) and Aoste (7 years), both located in Italy. On the other hand, the small duration of some construction consolidation centers (i.e., indicated as "CCC" in Figure 6) should not be necessarily treated as a failure, on the grounds that they were, by design, planned to serve the temporary needs of the respective construction projects. One of the prominent exceptions of this UCC category is the Heathrow airport UCC, which in spite of its initiated "CCC" type, it is still active and operating as a conventional consolidation center (Browne et al., 2005).

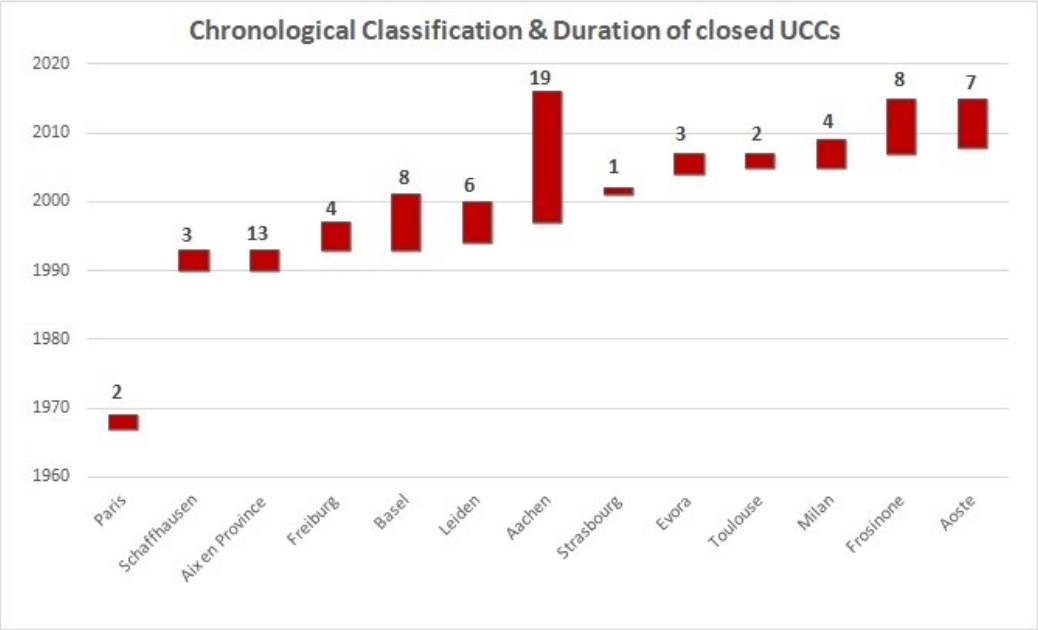


**Figure 5**: List of closed UCCs (by year of opening, closing and duration)

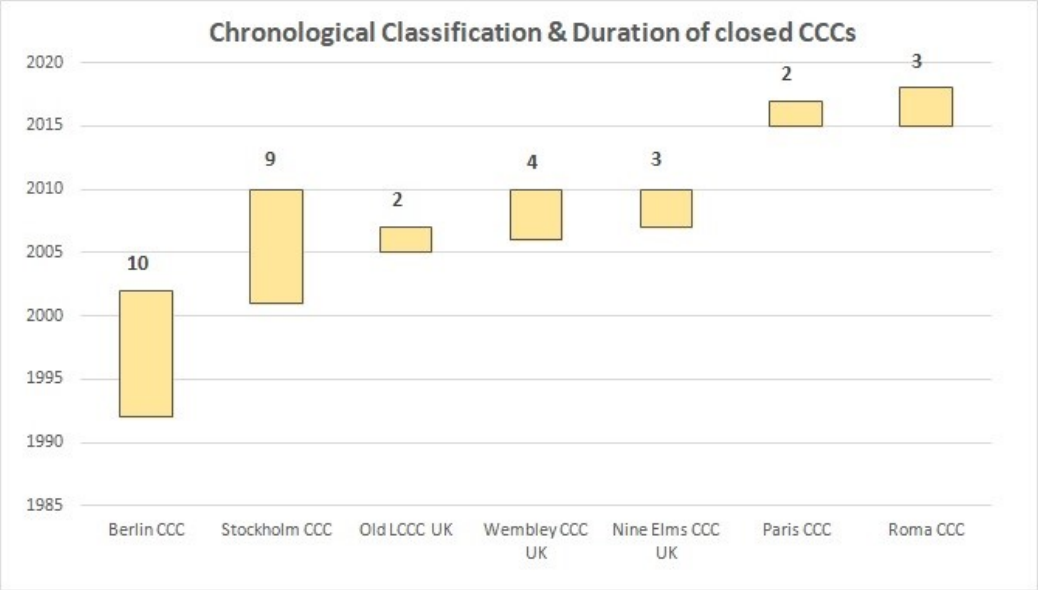


**Figure 6**: List of closed CCCs (by year of opening, closing and duration)

As a matter of fact, many typical urban consolidation centers failed to remain viable. According to a study carried out by Lagorio et al. (2016), among 83 examined UCC cases, where at least 50% of them were unsuccessful, the most important and frequent reason of non-viability for a UCC was their high operating costs. On top of high set-up costs, operational costs are very high, and especially when large numbers of users and, in turn, sufficient flows of goods are not attracted. This situation usually becomes sharper when public funding stops, and the scheme has to reach the break-even point. An interesting example is Schaffhausen UCC. Besides the carriers' willingness to participate, they were not willing to pay additional transshipments costs, which they tried to hand over to retailers. The retailers were dissatisfied with this extra cost

burden and preferred to abandon the advantages of short-term storage and bundled deliveries to their stores, hence leading the UCC to terminate operations (BESTUFS II, 2007).

Another frequently arising reason of failure is low or insufficient participation of carriers. A characteristic example is the UCC in Leiden, which reported low profitability because of dramatic low number of parcels handled. Most retailers arranged the deliveries processes on their own and were not willing to participate, so the costs of the UCC operation were not balanced by the respective benefits (SUCCESS, 2017). This is a clear example of lack or insufficient public regulatory support (Quak, 2008). However, the level of beneficial public involvement is based on a tight line. Freiburg and Basel UCCs have both reported quite limited number of participants and insufficient number of products handled through the UCC as primary reasons of non-viability (Browne et al., 2005; SUCCESS, 2017). A more in-depth analysis has revealed that a major barrier to participation were conflicts with the local authorities. Local authorities enforced strict regulations for city access. Transporters perceived these regulatory restrictions as enforcement towards mandatory participation in the UCC, hence causing their reaction and countermeasures. This reaction was even harder when they were left out of the corresponding decision-making process. A relative example is the case of Veloce Vicenza UCC (Italy), where local authorities tried to impose the use of the UCC, by forbidding the entrance in the city center to any other transporter. This regulation annoyed international logistics carriers who claimed their rights in court and boycotted the UCC. Akgün et al. (2019) suggest that urban freight transportation related policy measures should be implemented prior to the UCC establishment, so that carriers get familiarized with them and do not connect them directly with the UCC usage. Another reason was the reluctance for non-guaranteed service quality. Certain carriers felt that their participation in the scheme implied several risks such as goods handled by non-skilled personnel, safety risks or risks related to loss of competitiveness (e.g., in Gothenburg due to lack of information technology), confidential issues and loss of the direct supplier-customer relation (Akgün et al., 2019). Last but not least, limited participation can be also attributed to the fact that UCCs may not be able to serve the peculiar needs and logistical characteristics of certain product categories (Lagorio et al., 2016).

At the outset, the most frequently arising reasons resulting in UCC failure are related to financing, in terms of funding of the scheme, level of product flows, and cost and gains allocation model adopted. Additionally, it is of utmost importance that local authorities succeed to be involved and offer support to the UCC, without making the carriers feel that their interests are underestimated. Early engagement of all stakeholders in the design process could constitute a great help to UCC's acceptance. Confidentiality reasons, as well as inconvenience of some products are additional reasons often imbedding UCCs' viability. On the other hand, closed UCCs should not be necessarily viewed as project failures. Many closed platforms have substantially contributed in the reduction of environmental externalities caused by freight transportation or the improvement of distribution efficiency and productivity. For

example, the Construction Consolidation Center (CCC) in Berlin, created for the reconstruction of the Postdamer Platz in the city center, is commonly referred to as a successful example of CCC. The reduction in number of deliveries, traffic congestion, pollution, carbon dioxide emissions, waste and at the same time increase in safety, productivity and existence of "buffer stocks" are only some of the reported results (SUCCESS, 2017).

Tables 4 and 5 provide an overview of the key information about UCCs and CCCs in Europe respectively, having terminated their operation as of 2019. Again, cells indicated with "--" pertain to information that was not available in existing literature or could not be extracted from our desktop research. For completeness, it should be stressed once again that the construction consolidation centers in Table 5 provide *ad hoc* construction consolidation services. This needs to be particularly taken into account since these construction consolidation centers (CCCs) are normally supposed to terminate operations once the given construction project is delivered.

**TABLE 4 SHOULD BE INSERTED HERE**

**TABLE 5 SHOULD BE INSERTED HERE**

## 5. Practical Insights for Successful UCC Initiatives

This section presents practical insights for successful UCC initiatives that are linked to the critical factors obtained from literature (Section 3) and the state-of-practice review (Section 4). Specific factors at strategic, tactical, and operational level are identified and discussed below. These may support practitioners and interested parties to understand the key issues that should be taken into consideration for a viable and successful UCC. It is important to mention that these factors have been developed by capitalizing on the review of current UCC practice and especially by reports and case studies that describe in detail the UCC success factors presented below. The classification of each factor as strategic, tactical, and operational has been made by taking into consideration relevant research articles (Power, 2006; Gutierrez and Serrano, 2008; Akgün et al., 2019) categorizing similar factors and at the same time by discussing these factors in focus groups with practitioners and researchers in various fora and workshops (U-TURN, 2018).

**Factors at Strategic level**

- **Type of public involvement:** The support of local government and/or authorities for the operation of a UCC has been underlined as a prerequisite of utmost importance (Akgün et al., 2019). Support may include incentives to the companies that deliver their goods via the UCC or in kind support such as the provision of public infrastructure i.e. provision of depots with no cost in central locations that could better serve the aims of the UCCs (Browne et al., 2005; Duin et al., 2010; BESTFACT, 2014a; Lebeau et al., 2017). On the other hand, conflicts with local authorities signify a main determinant of project failure. Furthermore, the regulatory role of local authorities is also very crucial when UCC operations need to be supported (Akgün et al., 2019). Special rights that usually UCC delivery

vehicles have (e.g., use of bus lanes, daily access to historical center of a city) strengthen the use of UCCs.

- **Financing support:** Financial support constitutes the most essential supporting mechanism that authorities such as municipalities, regions and chambers of commerce, can activate for supporting the establishment and the operation of a UCC (Akgün et al., 2019). First, and most frequently, this comes through the provision of subsidies for the set-up costs incurred during the initial launching period and until the level of participation raises so that the scheme can be self-profitable (Lebeau et al., 2017). Start-up subsidies except for the local authorities could also derive from EU-funded projects (Browne et al., 2005). Reduction in start-up subsidies can dramatically affect the level of activity of a UCC, as happened in Kassel (Duin et al., 2010). In any case, it is crucial before the establishment of a UCC, to implement an assessment of the potential investment and investigate various scenarios by taking into consideration various scenarios of services provided, cost of services, amount of goods to be consolidated and delivered via the UCC that affect directly the income as well as the operating expenses of a UCC.
- **Regulation for city logistics operations:** Another important factor that could affect positively the operation and viability of the UCC is by regulating the access of freight vehicles to the area served by the UCC (Akgün et al., 2019). In general, three options have been pursued: i) enforcing the use of the UCC by law/regulation, ii) granting license only to those transporters who fulfill specific properties (in addition to UCC users) and iii) keeping the participation in the UCC voluntary and applying favorable measures or incentives for UCC users (Lebeau et al., 2017). The first option is ideally connected with UCCs that serve a specific site, either for construction or retail purposes. The second option was mainly applied by Dutch authorities who required from carriers to perform high and stable customer base, high truckload ratios, fleet of “clean” vehicles, or availability of depot assets near the city that could “host” the UCC (Duin et al., 2010; Lebeau et al., 2017). The third option is the most commonly used among UCCs. The participation of carriers in the UCC does not become mandatory, but users are benefited through regulations aiming to promote the attractiveness of the UCC. Incentives that are usually granted to end-users of UCCs (e.g., retail stores) are discounts in municipality/property tax based on the amount of products that will be delivered via UCC, and corporate sustainability public certificates that may act as a marketing tool to attract customers.
- **Size of UCC:** the size of the UCC has been recognized as a critical viability factor since it directly affects its development and operating costs and subsequently the critical volume of transactions required to reach the break-even point. Some UCC schemes may opt for small, “low-cost" facilities with a limited service portfolio, in order to reduce the start-up investment and the operating costs so that the required volume of transactions to break-even can be reasonably achieved. Although there was no clear evidence about a relationship between the size and failure rates of UCCs, the size effect on both development and operating costs puts pressures on the long-term financial sustainability of UCC operations. Therefore, a more conservative initial approach with view to size, with clear expansion plans in terms of scale and scope of UCC operations, would seem a

wise strategic option.

- **Location:** A UCC is ideally located 1-3 Km from the area that serves in order to get benefit of existing infrastructure, utilities, personnel etc. A location far away from the area served increases environmental benefits but may jeopardize the economic viability of the project due to increases in total routes (kilometers) travelled and the unit cost per delivery (Huschebeck and Allen, 2005). On the other hand, sites located outside the central city area would reduce real estate costs, avoid serious access restrictions frequently enforced in historical city centers and would eventually facilitate the upstream access of medium/big delivery vehicles to the UCC. It is thus crucial the location from market served to be carefully selected by taking into consideration various parameters such as ease of access to highway network (for trucks that deliver products to the UCC – inbound flows) but also close enough to the area of interest (for UCC trucks – outbound/consolidated flows).
- **Cooperative culture and trust among all parties:** A major key to high participation for a UCC is when stakeholders experience their participation as a mutually beneficial choice (Akgün et al., 2019). For sure, the creation of such culture is a challenge, especially in the case of UCCs providing service to the entire district/city with voluntary participation. In such cases, it is of utmost importance to sufficiently incentivize carriers to take part in the new initiative with the aim to justifying the economic profitability of the UCC initiative. As a matter of fact, most of the carriers prefer to maintain their company branding and the direct contact/interaction to final customers and are often reluctant to use UCCs, if they do not continue distributing parcels to customers with their own personnel. In Utrecht, before launching the UCC, it was ensured that private parties would be actively engaged in the process since the very beginning. The involvement of private parties would pertain to operational aspects mainly dealing with the execution of the last-mile delivery and the personnel employed by the UCC (i.e., personnel from carriers was also engaged for executing deliveries). As Nordtømme et al. (2015) claimed, the stakeholders' engagement is better ensured through the establishment of formalized network aiming to discuss and advise each other on problems in common. Examples of such network actions were the set-up of milestones to discuss the implementation process (e.g., Padova), sharing information platforms (e.g., La Rochelle) and permanent freight fora (e.g., Norwich) (Lagorio et al., 2016). In this way, stakeholders are better engaged in the process, they feel that their interests are well recognized and receive trust by their cooperators who accepted to share responsibilities. These are all contributing towards a better acceptance of the "joint" UCC initiative (BESTFACT, 2014b).

**Factors at Tactical level**

- **Catchment area:** The catchment area should be determined in close dependence with available sites for locating the UCC and the density of customers both within the city boundaries as well as in the broader city surroundings. A typical catchment area covered by a UCC is between 3-5 $Km^2$ (Köhler and Groke, 2004; Quak and Hendriks, 2012).

- **Fleet composition:** The careful selection of distribution vehicles is also a critical factor for a successful UCC operation (Akgün et al., 2019). Although electric vehicles have no emissions and are environmental friendly, yet city logistics operations include multiple trips within the daily shift, and this cannot be supported usually by electric cars that have a limited range. To this end, a mix of vehicles are usually used that include electric vans and cargo bikes (for historical centers) as well as truck with alternative fuels such as natural gas (CNG). Furthermore, the load capacity of the fleet should be taken into consideration together with the conditions (e.g., ambient, chilled, frozen) needed for product delivery. In general, UCCs handle ambient products/cargo in order to avoid the special equipment (e.g., thermotainers) that is needed in cold supply chains.
- **Information systems:** UCCs are mainly cross-docking facilities where products from different suppliers are consolidated and delivered to end customers. The aforementioned task should be executed accurately, fast and with low cost, in order for the UCC to have a competitive advantage over direct deliveries. A key factor to fulfill the aforementioned requirements and provide end-to-end visibility to all key players is a strong, integrated and real-time information system (e.g., last-mile orchestration platform) that will inter-connect the suppliers' systems with the UCCs transport management system (TMS). Furthermore, the system should also support the drivers' operations that include proof-of delivery and information-of-delivery actions. In addition, other characteristics that the information system may support include: cash-on-delivery (COD), driver's rating by the end customer etc.
- **Value-added services:** An increased number of Value-Added Services (VAS) such as same-day delivery, short-term storage and handling of fresh food would definitely ensure increased number of customers, like in La Rochelle and Lucca (Lagorio et al., 2016). Along the same lines, reverse logistics and (packing) recycling would also upgrade the service portfolio of a UCC and raise its attractiveness (Lebeau et al., 2017). The aforementioned services should be provided in high quality and in a reasonable cost in order for the customer experience to be maximized (Akgün et al., 2019).

**Factors at Operational level**

- **Well-defined processes:** Since there are multiple actors that are engaged in city logistics operations and especially in freight transportation via UCCs, it is very important that well-defined processes that deal with the physical handling as well as the transactional part of cargo exist. These processes should be followed by all engaged actors since they are critical and affect operational cost and customer service.
- **Suitability of product for common delivery:** Although a UCC may attract multiple clients, this does not necessary imply consolidation of products to be delivered. There are various restrictions related to the type of products that can be delivered in a common truck. These constraints usually pertain to the type of product (e.g., chemical vs. food) or thermal restrictions (e.g., ambient vs. chilled). It is thus very important for the UCC operator to define which type of products can be trans-shipped via the UCC (Akgün et al., 2019), with most known cases

involving the consolidation of ambient products that have no special restrictions or handling requirements such as chemical products, etc. In addition to the physical characteristics of the product (e.g., food, chemical, temperature-controlled), other types of regulatory restrictions (e.g., pharmaceutical, medicines, money transfers) and considerations about the potential UCC beneficiaries may also apply. The degree of consolidation is heavily affected by the number and fragmentation of shippers. The current experience has shown that tailored logistics services, products with specialized handling/regulatory requirements or dedicated UCC operations to a unique shipper are very limited in existing UCC cases (e.g., Dublin) (Browne et al., 2005). Other types of products or companies that are not envisaged as potential beneficiaries of UCCs are time-sensitive products (e.g., perishable food, newspapers, seasonal products) and big companies (e.g., major supermarkets, freight transport companies, big wholesalers) usually arranging dedicated deliveries from in-house consolidation centers by means of their own distribution fleet (Browne et al., 2005; Huschebeck and Allen, 2005; Lewis et al., 2007; Triantafylloy et al., 2014). At the outset, the critical challenge for such in-house/private UCC operators is whether the delivery points are sufficiently focused on geographical terms to provide high rates of fleet utilization. If the above does not hold true, then they also represent potential beneficiaries of public UCCs.

- **Density of delivery points:** In order to be viable, a UCC should serve a significant number of customers (usually 50-70 drops per trip) that are in a certain area as already described. In doing so, the travel times of a truck per trip should be minimized, and customers should be located very closely in the area of service. Thus, it is essential to identify the optimal UCC location and carefully select the type of products to be delivered (i.e., suitability of products).
- **Number of common delivery points:** A way to maximize the drops per trip is for a UCC to cooperate with suppliers (i.e., customers of the UCC) that have common end customers (i.e., delivery points). In fact, when we deal with business-to-business (B2B) deliveries, the aim is when using a UCC, to consolidate products from multiple suppliers of an end-customer (i.e., retail shop) in order to execute a single drop-off per day. In that way, a truck can deliver simultaneously multiple orders placed to different suppliers from an end customer and thus increase the number of drops per trip.

The aforementioned factors are crucial for the viability of a UCC and the underestimation of their importance may jeopardize the entire UCC operation. The latter may be reflected on high operational cost, low productivity, small number of customers, lack of synergies/collaborations between transport carriers which usually result to low customer service and eventually closure. Furthermore, it is also important to mention that according to Akgün et al. (2019), local transport policies can support the successful operation of a UCC when they are put in place by a proactive local authority whose aim is the development of a beneficial collaboration between public and private sector.

## 6. Conclusions

Last mile deliveries have significant economic, environmental and social implications. The aim of this paper was to provide a comprehensive state-of-practice review of UCCs in Europe that are currently operating or have terminated their operation (i.e., closed) at the time of writing. We adopted the Systematic Literature Review (SLR) methodology and followed an integrated approach, combining both literature review and primary desk-based research among open/closed UCCs. Overall, we came up with a list of 82 UCCs in 17 European countries, of which 62 are open and still operational in 2019, while 20 UCCs have terminated their operation. At a subsequent step of the analysis, we aimed to identify and critically assess key success factors and viability drivers, common sources of failure, as well as key challenges in the design, operation and management of UCCs.

The results from the literature review showed that the adoption of UCCs can be beneficial for the execution of urban freight transportation with benefits ranging in various fronts: i) decrease of operational cost (i.e., less trips, higher load factor, less traveled Km), ii) upgraded customer service levels (i.e., better delivery KPIs, increased on-time deliveries, same-day deliveries) coupled with a decrease in delivery cost, iii) more environmental friendly transportation and iv) a rich portfolio of value-added services. On the other hand, a series of prerequisites need to be brought forward for the viability of the UCC such as: i) the provision of high-quality services at reasonable cost, ii) consolidation and handling of significant freight volumes, iii) trust and common operating culture between UCC customers and the UCC operator and iv) active support from local government and authorities at multiple levels.

We believe that this research provides an added value since it may support both practitioners as well as researchers to better understand city logistics as a discipline, and particularly the role of UCCs in a city environment. However, additional research needs to be done in the future targeting in business as well as technical topics. As far as business issues are concerned, it would be worth investigating ways of strengthening stakeholder collaboration and transforming UCCs to a sustainable, smart, and integrated freight transportation hub. A particularly interesting direction of future research would be to explore ways and business models that would be able to promote the longevity of construction project-based CCCs by successively migrating to a conventional UCC type of operations, once the construction project is delivered.

As far as the stakeholders' collaboration is concerned, interested parties should focus on business synergies, which can be beneficial and enhance collaborative logistics operations. In addition, new organizational models such as business clusters should be developed in order to create viable UCC business models. It is worth mentioning that the body of research knowledge and practical experience on the content and design of business models for UCCs remains scarce, while several UCC initiatives have not flourished due to lack of or poor business models. Moreover, very few studies have quantified in monetary terms the changes in external costs that a UCC can achieve, as well as costs and revenues associated with UCC operations and the main factors driving the profitability of UCC operations. The latter area requires more support and guidance, as it promises considerable potential for future research. As far as technical topics are concerned, research should focus on the maximization of UCC productivity

via simulation modeling where various what-if scenarios may be tested and evaluated via certain KPIs (e.g., on-time delivery, loss and damage, number of orders delivered). In addition, future research could also focus on UCC fleet optimization mainly via the development of loading and routing algorithms that could take into consideration various constraints (e.g., vehicles' capacity, time windows, existing road network characteristics) and provide fast, near real-time solutions. Dynamic routing in UCC environment is also an interesting area for further research especially when unexpected events appear (e.g., traffic, weather conditions, increased service times) or new tasks (e.g., pick-up and delivery) arise during the execution of a delivery trip.

Last but not least, the pandemic of COVID-19 where physical stores were closed, as well as the significant increase of electronic (E-commerce) and quick commerce (Q-commerce) have amplified the need for timeless and omni-channel distribution of products. Q-commerce enable companies to respond quickly and efficiently to increased demand requirements for delivery due to COVID-19, while simultaneously complying with social distancing recommendations. Q-commerce is actually the next generation of e-commerce and brings small quantities of goods to customers almost instantly, whenever and wherever they need them via micro-consolidation centers (i.e., smaller UCCs). The latter are expected to play a pivotal role both for B2C deliveries (e.g., home deliveries, Pick-Up & Drop-Off points, smart lockers), as well as for B2B order fulfillment that has been transformed to more frequent and smaller shipments. Furthermore, the need for more sustainable and smart city logistics operations will lead UCCs to use vans with alternative fuels (e.g., CNG, electric, bi-fuel) ideally in combination with electric cargo bikes. Finally, the rapid development of autonomous vehicles for cargo movement will also transform the way last-mile logistics will take place in the years to come. Initial pilot tests of using autonomous vehicles for delivery of groceries have shown quite encouraging results.

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