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MULTI-LAYERED INTEGRATED URBAN FREIGHT DELIVERY NETWORK – CASE STUDY OF BEST PRACTICES AND SUGGESTIONS FOR IMPROVING SOCIAL SUSTAINABILITY

Final Report

by

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EXECUTIVE SUMMARY

Freight transportation is an indispensable part of our daily activity, serving nearly all parts of the economy and supporting the daily activities of 126 million households, 7.7 million business establishments and 90,000 government units. A conservative estimation of GDP produced by freight transportation¹ was \$281.4 billion, which is at least 43% of the entire transportation sector. The 2010 decennial census reported that the urban population, for the first time in U.S. history, exceeded 80% of the total population, and it grew faster than the rest of the country from the 2000 decennial census. Freight demand is also expected to grow since goods demand is positively correlated with population growth and economic expansion, but it increases faster than the population. Moreover, the total of domestic freight movement is projected to increase by 31% between 2015 and 2045. And, trucking dominance in goods movement will continue; approximately 68.6% of goods are expected to be transported by trucks. New trends in inventory management in retail stores, keeping minimum stocks and increasing the store floor space for sales; and the advancement of just-in-time logistics will further boost the frequency of small-package deliveries to retailers, large office buildings and individual consumers. Similarly, the fast-growing online shopping will add to the growing small-package deliveries. Every year, the U.S. e-commerce market grows at a double-digit pace. Against the backdrop of these estimates and trends, it is large, highly populated and built cities that will bear the brunt of a fast increase in freight delivery demand. Most goods are originated in and destined for cities. Moreover, the first leg (first-mile) as well as the last leg (last-mile) of goods deliveries are mostly made by trucks. Delivery trucks must compete for space with other transportation.

The objectives of the study were (1) to identify success factors and barriers of Urban Consolidation Center (UCC) implementation; (2) to summarize the sustainability impacts of UCCs; and (3) to contemplate the transferability of the lessons learned to address an equity issue: food deserts. A UCC is a “facility involving the transshipment of goods directed to urban areas, aiming to consolidate deliveries, and thus provide greater efficiency in the distribution process by increasing the truck load factor and decreasing the number of trucks used” (Panero, Shin, & Lopez, 2011, p. 4) with the objectives of improving environmental, economic and social sustainability.

A review of four best UCCs—Elcidis, Bristol, Meadowhall, and Cityporto—clearly presented benefits of UCCs. First, the number of truck trips and distances decreased significantly. In Elcidis UCC, each delivery vehicle could save three hours per delivery and total distance by 61%. In the case of Bristol UCC, DHL Excel, the UCC operating company, claimed that it has achieved 100% on-time delivery. Also, the number of trips decreased by 65% in Meadowhall UCC. The significant

¹ To the author’s best knowledge, reliable public data only for the freight transportation industry was not available. It is a conservative estimation because the GDP contributions of air, water, and pipeline were not included. The percent calculation was only based on for-hire and in-house trucking. Therefore, the provided figure is the minimum contribution.

reductions in delivery frequency, total truck miles traveled, and delivery time can be translated into a significant direct and indirect reduction in congestion, emissions, noise, safety concerns, and adverse health impacts. The amount of air pollutants such as NO_x, CO₂, SO_x, and VOC decreased. It should be noted that CO₂ is the major source of greenhouse gases. In 2016, CO₂ was responsible for 81% of the greenhouse gas emissions.

It appears evident that UCCs generate positive externalities. However, it was not clear whether studies have been conducted and reported UCCs' positive externalities in terms of improving social sustainability. While some aspects of social sustainability, such as public health and the quality of life, are affected by the environmental and economic sustainability, a clearer discussion of UCC's benefits on social sustainability needs to be considered. *"If any one [of the three] pillars [of sustainability] is weak then the system as a whole is unsustainable."* This study suggests applying the lessons of implementing UCC and models of city logistics to improve one of the serious equity issues: food deserts. The rationale is simple enough for probably all planners to know in a theoretical sense. The case studies and review of recent literature indicate that making a UCC financially sustainable is the most difficult task in beginning a UCC discussion. It seems there are several strong cases for not planning UCCs both from the public and private sectors' perspectives. At least one U.S. study asserted that UCC schemes' chance of success in the U.S. is low.

With that said, applying UCCs' schemes shows promise for projects aimed at improving social welfare. As an example, delivering fresh foods to residents in food deserts was suggested and preliminary study introduced. The lack of access to fresh foods within reasonable distance and at affordable prices has become a public health concern for individuals living in underserved inner-city communities and remote rural areas. Such areas are generally called food deserts. While the introduced study is still in progress, a few macro-level network models were developed, and a sensitivity analysis has been conducted. Delivery routes by trucks, e-bikes, pick-up buses, parcel lockers, and pop-up trucks were mathematically formulated. Preliminary results show a potential of implementing a UCC for door-to-door fresh food delivery for residents in food deserts. One may argue that existing large grocery stores and third-party logistics carriers like UPS could serve those neighborhoods. However, since many food deserts are located near or within locations with high crime rates, grocers and other carriers are not willing to make such door-to-door deliveries. This is where the public sector steps in and helps the underrepresented.

1.0 INTRODUCTION

Freight transportation is an indispensable part of our daily activity, serving nearly all parts of the economy, supporting daily activities of 126 million households, 7.7 million business establishments and 90,000 government units (Bureau of Transportation Statistics, 2017). Its contributions span from connecting stakeholders in supply chains—i.e., suppliers, retailers, end-users, etc.—to generating directly and indirectly freight-associated jobs to strengthening the overall competitiveness of a city, region, state, and nation. A conservative estimation of GDP produced by the freight transportation² sector was \$281.4 billion, which is at least 43% of the entire transportation sector (Bureau of Transportation Statistics, 2017). An economic impact study for the State of Maryland estimated that the freight industry generated nearly 90% of the state gross domestic product (GDP) produced by the entire transportation sector (Shin, Bapna, Farkas, Bonaparte, & Nickkar, 2019). The industry’s job multiplier was 1.70; that is, 70 additional jobs are supported by every 100 jobs in the freight transportation sector.

Cities are economic hubs and where most goods are produced and consumed. The 2010 decennial census reported that the urban population, for the first time in U.S. history, exceeded 80% of the total population, and it grew faster than the rest of the country from the 2000 decennial census (U.S. Census Bureau, 2012). Freight demand is also expected to grow since goods demand is positively correlated with population growth and economic expansion, but it increases faster than the population. While the U.S. population grew by 12.6% between 2000 and 2015 (U.S. Census Bureau, 2015; U.S. Census Bureau, 2012), the U.S. GDP, as a proxy for freight demand, expanded by 30.6%, despite the economic recession between December 2007 and June 2009 (Bureau of Transportation Statistics, 2017). Moreover, the total of domestic freight movement is projected to increase by 31% between 2015 and 2045. And, trucking dominance in goods movement will continue; approximately 68.6% of goods are expected to be transported by trucks (Bureau of Transportation Statistics, 2017). During the same time period, the population is forecasted to grow by 18% (U.S. Census Bureau, 2018). New trends in inventory management in retail stores, keeping minimum stocks and increasing the store floor space for sales, and the advancement of just-in-time logistics will further boost the frequency of small package deliveries to retailers, large office buildings and individual consumers. Similarly, the fast-growing online shopping will add to the growing small package deliveries. Every year, the U.S. e-commerce market grows at a double-digit pace (Lindner, 2015). A 2017 consumer survey revealed that approximately a quarter of American households order some groceries, up from 19% in 2014, and more than 70% of respondents are likely to use online food shopping within 10 years (Daniels, 2017). All these trends only point to a sharp rise in small-package delivery demand that will result in more trucks and vans on narrow and clogged city streets.

Against the backdrop of these estimates and trends, it is large, highly populated and built cities that will bear the brunt of a fast increase in freight delivery demand. Most goods are originated in

² To the author’s best knowledge, reliable public data only for the freight transportation industry was not available. It is a conservative estimation because the GDP contributions of air, water, and pipeline were not included. The percent calculation was only based on for-hire and in-house trucking. Therefore, the provided figure is the minimum contribution.

and destined for cities. Moreover, the first leg (first-mile) as well as the last leg (last-mile) of goods deliveries are mostly made by trucks. Delivery trucks must compete for space with other transportation (Williams & Carroll, 2015). Several concerns have arisen. First, this will put more strain on an already clogged transportation network. Ninety-five of America's 100 largest metro areas saw increased traffic congestion between 2013 and 2014; a year before, only 61 cities experienced increases (Schrank, Eisele, Lomax, & Bak, 2015). Second, most local delivery trips are short and need frequent stops, which implies lower fuel efficiency and more emissions. Indeed, in 2014 the cost of truck congestion from 471 large urban areas was approximately \$28 billion; that reflects yearly operating time and wasted fuel costs (Schrank, Eisele, Lomax, & Bak, 2015). Third, a significant share of environmental externalities from the transportation sector is also incurred by goods movement. NOx emissions from trucks increased by 63.4% between 2000 and 2016 (Bureau of Transportation Statistics, 2017). Moreover, the trucking industry produced 23% of the GHG emissions from the entire transportation sector, and nearly 76% of the GHG emissions from freight movement. A case study of UCCs in La Rochelle, France, and Norwich, UK, found that even if the vehicles represent only 10% of the transport in the urban sectors, they produce more than 40% of the pollution and noise generated by local traffic (Breuil & Sprunt, 2008). The last concern is safety. While large trucks accounted for roughly 4% of all registered vehicles in the U.S., they were responsible for approximately 8% of all fatal vehicle crashes in 2016 (National Highway Traffic Safety Administration, 2018).

The rationalization of “last-mile” or “final mile” freight deliveries in large central cities has garnered much interest in the last several decades, especially since 2000, in order to address environmental, economic, and social sustainability issues. As a response, many European countries and several Asian countries proposed the urban consolidation center (UCC) as one of the alternative freight transportation demand management strategies. The primary objectives of UCCs from the public sector's point of view are to reduce vehicle emissions, delivery trips, and safety issues. To the private sector, saving logistics costs is the foremost objective. UCCs enable the collaboration among shippers, carriers, and retailers to consolidate deliveries, resulting in fewer truck delivery trips while achieving the same throughput (Browne, Sweet, Woodburn, & Allen, 2005; BESTUFS, 2007).

1.1 Study Objectives

The objectives of the study were (1) to identify success factors and barriers of UCC implementation; (2) to summarize the sustainability impacts of UCCs; and (3) to contemplate the transferability of the lessons learned to address an equity issue: food deserts. The primary objectives were to find success factors of UCC implementation, summarize environmental impacts, and find elements that can be transferred to apply UCC schemes to propose healthy food deliveries to underrepresented population groups with limited transportation and healthy food access, which

has not been discussed in the field. Of course, many case studies of UCC schemes have been conducted and published (Allen, Browne, Woodburn, & Leonardi, 2012; Allen, Browne, Woodburn, & Leonardi, 2014). They tried to classify UCCs into several types, depending on service areas and operation/governance, investigated the viability of UCCs, and evaluated economic and environmental impacts after implementing UCCs. But few, if any, addressed the role of UCCs as a tool for improving equity/social justice.

1.2 Organization of the Report

After defining UCC schemes and discussing their potential benefits, four best practice case studies of UCCs were discussed in detail, building on the authors previous case studies (de Cerreno, Shin, Strauss-Wieder, & Theofanis, 2008; Panero, Shin, & Lopez, 2011) and the review of the latest literature. The selected best practice UCCs were: Elcidis, La Rochelle, France; Bristol Urban Consolidation Center, UK; Meadowhall Consolidation Center, Yorkshire, UK; and Cityporto, Padua, Italy. Each UCC was described in terms of several important criteria for UCC implementation such as initiator, service area, ownership, financial status and their impacts. By synthesizing the case studies, six lessons from the successful or failed UCC implementation were identified and further discussed. The next section summarized the cases in terms of the three pillars of sustainability: environmental, economic, and social sustainability. Then, the report pointed out the lack of UCC studies regarding the improvement of social sustainability. Lastly, in the discussion section, a new suggestion based on the author's research is briefly discussed. In addition, the section argued for the rationales of government involvement.

2.0 URBAN CONSOLIDATION CENTER

2.1 Defining an Urban Consolidation Center

Many facility names are interchangeably used to indicate an urban consolidation center (UCC) such as urban distribution center, city logistics center, city terminals, freight consolidation platform, urban transshipment center, shared-use freight terminal and cooperative multi-carrier delivery (Browne, Sweet, Woodburn, & Allen, 2005; Regan & Colob, 2005; Holguin-Veras, Silas, & Polimeni). Likewise, a UCC is defined in various ways depending on a UCC initiative's objectives, scope and service areas. In this study, the sustainability objectives were added to the definition that was coined by the author's previous study (Panero, Shin, & Lopez, 2011).

A UCC is a “facility involving the transshipment of goods directed to urban areas, aiming to consolidate deliveries, and thus provide greater efficiency in the distribution process by increasing the truck load factor and decreasing the number of trucks used” (Panero, Shin, & Lopez, 2011, p. 4) with the objectives of improving environmental, economic and social sustainability.

In this scheme the carriers pay the neutral UCC operator a fee per delivery made and save money by not having to make the final leg of the delivery themselves (Holguin-Veras, Silas, & Polimeni, 2008). Another model is that the receivers—e.g., retail stores in a shopping mall and end users—pay the neutral UCC operator a fee per delivery made and receive packages on time and when they want. UCCs are generally located in close proximity to or within the service area. The area can be a specific site such as shopping center, hospital, airport and construction site; part of a city-like central business district (CBD); or an entire city. [Figure 1](#) illustrates potential delivery trip changes after implementing a UCC.

The concept of delivery consolidation in a shared-use freight facility was first studied in the 1960s in France, followed by UK, Netherlands, and Italy in the 1970s (Vaghi, Oesterie, Siciliano, & Grea, 2014). These earlier investigations were initiated by the government sector. In the U.S. a similar study can be traced back to the early 1970s. A feasibility study of a consolidation terminal was conducted between 1972 and 1974 in Columbus, Ohio, (Browne, Sweet, Woodburn, & Allen, 2005; Allen, Browne, Woodburn, & Leonardi, 2012). However, none of the early European and U.S. studies were implemented. They failed to attract much interest from private sector stakeholders—e.g., shippers, carriers and receivers. In the 1990s, the interest in freight consolidation was revived in response to various economic and environmental issues due to a rapid increase in freight deliveries into high-density cities with domestic and international economic expansion. Now most UCC initiatives have been implemented in Europe. The revival of UCCs was led by Germany. In the 1990s, the German government planned more than 70 UCCs; a number of the plans were implemented and a few UCCs are operating today or remained until recently (Browne, Sweet, Woodburn, & Allen, 2005). Switzerland followed Germany and implemented five pilots, but none

of them are in operation now (BESTUFS, 2007). This was due to the lack of participation that left the UCC operation financially unsustainable.

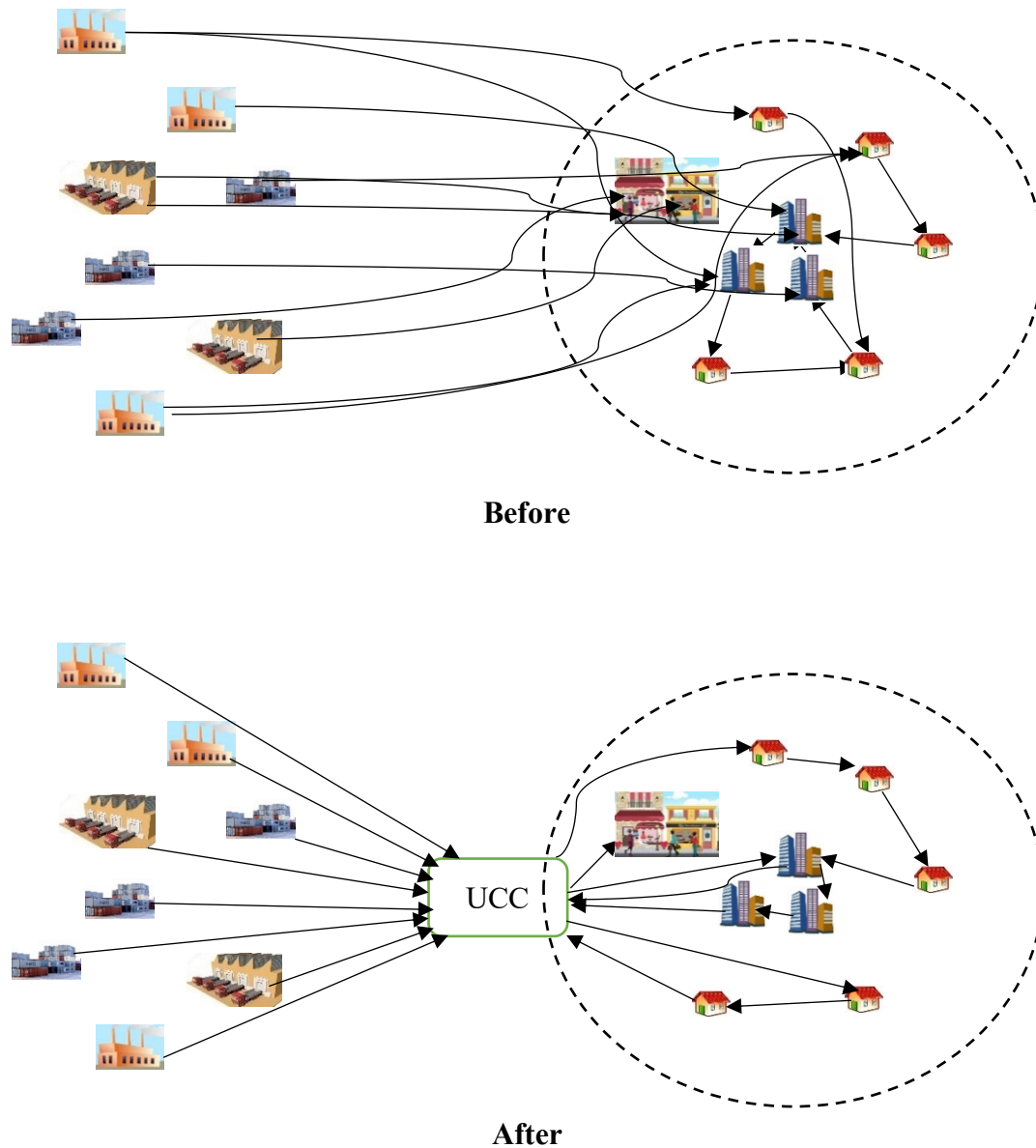


Figure 1: Delivery trip organization before and after UCC implementation

While the support of delivery consolidation has not been broad, yet an increasing number of public and private sectors have realized that “the heterogeneity of actual practices can be grouped up under the umbrella category of consolidation center” and the emergence of a number of interesting

experiences based on some trends—such as frequency deliveries of small packages, growing outsourcing to third-party carriers, the diffusion of truck access regulatory measures—in the freight logistics market has risen (Vaghi, Oesterie, Siciliano, & Grea, 2014). With these trends, UCCs started to be considered as a strategy to enhance the effectiveness of urban distribution.

By improving the load factor of delivery trucks destined for congested urban locations and by optimizing delivery travel routes, the total number of delivery trucks on the road and total truck miles traveled (TMT) would decrease (Triantafyllou, Cherrett, & Browne, 2014). Sharing facilities and providing other value-added services would facilitate logistics activities and generate synergies (Vaghi, Oesterie, Siciliano, & Grea, 2014). Expected synergies are realized from the economies of scale from the concentration of logistic activities into one location.

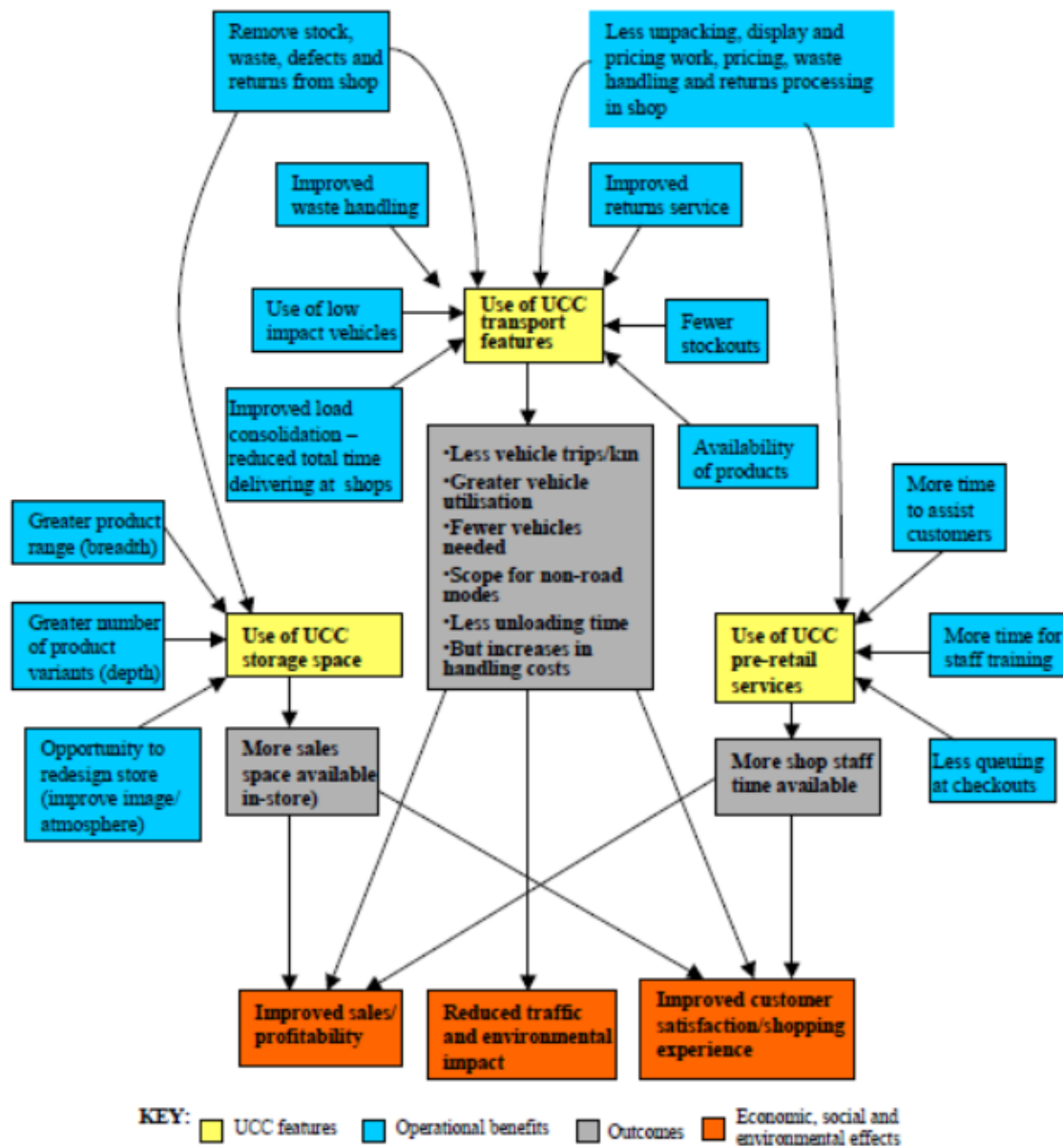
2.2 Potential Benefits of UCC for Public and Private Stakeholders

Figure 2 visualized a typical UCC business model in relation to various logistics activities and value-added services (Browne, Sweet, Woodburn, & Allen, 2005). The figure also summarized potential benefits to businesses, customers, and traffic and environmental impact. A few transportation services would make a UCC financially self-sustainable. Shippers and long-haul carriers unload goods at the UCC, and they do not need to make final deliveries to the destination, avoiding traffic congestion. Re-grouped goods are to be delivered to stores and customers. Using fewer number of trucks with higher loading factors and optimized delivery routes, customers enjoy reliable and predictable package deliveries. In addition to consolidation, successful UCCs provide additional services such as restocking, returning, unpacking, tagging, and waste handling. Therefore, store owners do not need to have a large space for inventory for receiving new goods and shipping back unsold and returned products. Instead, store owners can make more products available for sale, which potentially increases their revenue. Often UCCs provide temporary storage services. Those businesses with wide seasonal variations could use this service to rapidly change products. Finally, pre-retail services—e.g., unpacking, price tagging, handling returns, etc.—reduce the number of staff for managing stores or make existing staff available for customer services. In summary, UCC operations open the door for new business opportunities. Drivers may experience less conflicts with delivery trucks. And congestion and air and noise pollution would be reduced.

To the public sector, the most attractive benefits and justification of UCC implementation is a reduction in traffic congestion and air pollution. A recent study summarized several benefits based on the review of 93 UCCs (Verlinde, 2015). The range of impacts widely varied by studies. Shipment consolidation by maximizing load factor significantly reduced the truck delivery distances by around 12% to 53%. In addition, 93% of the surveyed UCC-participating businesses observed a positive impact on energy consumption. Another case study found that freight consolidation improved the truck load factor by 15% to 100% which resulted in a 30% to 45% decrease in total delivery trips and a 30% to 45% reduction in delivery travel distance (Browne, Sweet, Woodburn, & Allen, 2005). Also, the amount of air pollutant emissions dropped by 25%

to 60% (Allen, Browne, Woodburn, & Leonardi, 2012). To the private sector stakeholders, these findings indicate UCCs would be potentially feasible. Vehicle trip frequency and distance reduction would result in the use of fewer delivery trucks, less energy consumption, and eventually, logistics cost savings. Therefore, total logistics costs would be saved. These findings may be convincing evidence for the public sector to promote UCC initiatives.

It should be noted truck deliveries themselves are not to be blamed for the negative externalities. Negative impacts of urban freight delivery in most cities are also due to inadequate loading and unloading zones, and roadway geometry as well as related compulsory measures. [Figure 3](#) shows delivery trucks blocking traffic lanes to load/unload goods and an 18-wheeler blocking traffic due to roadway geometry too narrow for large trucks. The last picture shows excessive emissions from an old truck. In this sense, implementing UCCs will provide the government with opportunities to revise and develop delivery-related restrictions and incentives, and to introduce electric-powered trucks and non-motorized delivery modes like tricycles.



Source: (Browne, Sweet, Woodburn, & Allen, 2005, p. 10)

Figure 2: Range of potential logistics and pre-retail activities at a UCC and possible benefits



No loading zone, Chinatown, San Francisco



Parked and blocked the right-turn only lane just before Light St & E. Lombard St., Baltimore



Inadequate street geometry, York Rd. Northbound, Lutherville-Timonium, MD



Emissions from an old truck, Northbound I-695, Lutherville-Timonium, MD

Photo credit: the author

Figure 3: Impacts of Delivery Trucks

3.0 BEST PRACTICES: CASE STUDIES

This section discusses the types of UCCs by service area characteristics and ownership/management structure. Three types of UCCs are introduced, following one of the most widely used typology from Allen et al. (2012). Then, four selected best cases are discussed. The case study UCCs were selected from the list of consolidation centers reviewed by the author's earlier study (Panero, Shin, & Lopez, 2011) because they are still operating, financially sound and some of the most frequently discussed UCCs in the literature—i.e., rich information.

3.1 Typology of UCCs by Service Area Characteristics

Three types of UCCs were defined based on a thorough review of 114 UCC schemes in 17 countries: (1) UCCs serving all or part of an urban area; (2) UCCs serving a large site with a single landlord; and (3) UCCs serving a construction project (Allen, Browne, Woodburn, & Leonardi, 2014).

First, UCCs serving all or part of an urban area are the most commonly observed type and they often serve a specific part of an urban area. In general, this type of UCC is initiated by the local authority to address traffic and environmental problems (Allen, Browne, Woodburn, & Leonardi, 2014). The joint distribution system (JDS) in Motomachi, Yokohama, Japan, is a good example. JDS serves only the Motomachi district, covering 500 shops as well as 850 individual homes (Figure 4) (Taniguchi & Qureshii, 2014). It was piloted with municipal subsidies between 1999 and 2001 and its objectives were reducing CO₂ emissions and congestion and improving the district's streetscape. In 2004, it became financially sustainable without subsidies. Around 85% of goods delivery to the district is covered by JDS. JDS is managed by a neutral carrier that is financially supported by the Motomachi Shopping Street Association. With JDS implementation, the number of delivery trips



Motomachi District



Motomachi Shopping



Designated Parking Space



Distribution Center

Source: (Taniguchi & Qureshii, 2014)

Figure 4: Joint delivery system of Motomachi District,

to the district decreased to 3 times per day (by the neutral carrier) from 33 times per day (by 11 individual carriers).

Second, a large site such as a shopping center, hospital or airport with a single landlord is often covered by a UCC. For this type, one of the most popular examples is a UCC scheme serving London Heathrow airport retail, restaurant and catering services (Allen, Browne, Woodburn, & Leonardi, 2014). A single-landlord UCC can be managed more efficiently and profitably than other ownership types. Another interesting aspect of this UCC is that deliveries through the UCC is a prerequisite for tenants' store rental contracts to serve retail, catering and restaurants in the Heathrow airport.

Third, UCCs can be adopted to serve a construction site. Again, the most famous example is London Heathrow airport during major development work (Allen, Browne, Woodburn, & Leonardi, 2014). This type of UCC was also employed in Hammarby, Stockholm, for a major housing project. These UCCs mostly exist only during construction projects. This scheme can be made mandatory through the planning permission process.

3.2 Best Case Practices

This study reviewed nearly 50 UCCs in Europe and Japan that have had better operational performance compared to others. Of them, four selected best-case practices are discussed: one UCC from France, two from UK, and one from Italy. There were several criteria for selection. First, the selected UCCs are some of the most-frequently mentioned. Second, compared to other UCCs, more information was available. Third, all selected cases have long histories and are in operation.

3.2.1 Elcidis, La Rochelle, France

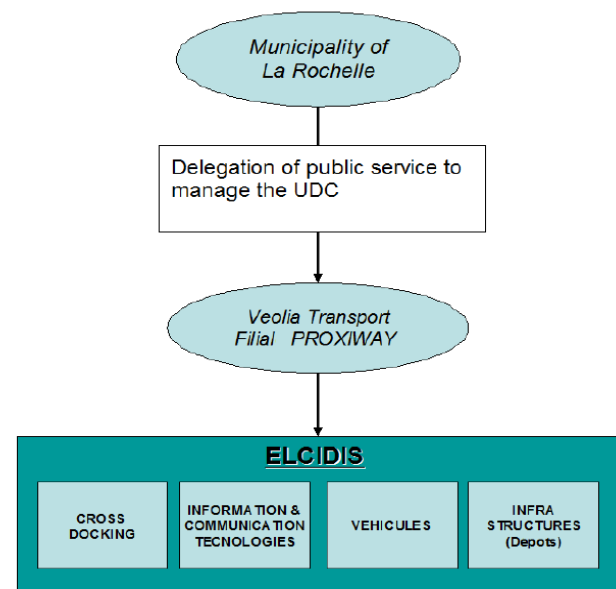
La Rochelle is a city on the French Atlantic coast with population of about 135,000. It is one of the first European cities with a traffic policy aimed at reducing environmental pollution (Vermie, 2002). La Rochelle UCC, Elcidis, was initiated in February 2001 by the Urban Community of La Rochelle with the Chamber of Commerce and Industry, private sector stakeholders, and research institutes (Trentini, Gonzalez-Feliu, & Malhence, 2015). The primary objectives were to promote delivery in electric vehicles, optimize goods distribution and relieve congestion in the city's historical center with an environmentally friendly approach and delivery reorganization (Vermie, 2002; Breuil & Sprunt, 2008). The pilot UCC was launched as part of the electric vehicle city distribution systems (ELCIDIS) European project that also supported pilots in Rotterdam, Stockholm, Eriangen, Regione Lombardia/Milan, and Stavanger (Vermie, 2002; Breuil & Sprunt, 2008).

The most sensitive part of the project was the difficulty in reaching financial equilibrium (Trentini, Gonzalez-Feliu, & Malhence, 2015). Until 2006, Elcidis UCC was funded by the municipality of Rochelle and other public bodies and the ADEME (French Environment and Energy Management Agency) (ADEME, n.d.). To help the pilot in the start-up phase, the municipality provided premises of about 750 m² (about 8,000 sq. ft.), vehicles, equipment, computer hardware, and office furniture (Vermie, 2002).

In 2006, the Urban Community of La Rochelle decided to delegate the operation of this public service to Veolia Transport, a private public transport company, in order to perpetuate the system and permit new development (Figure 5). To give the manager incentive for expanding the operations, it was decided that monetary compensation would be remunerated based on the number of parcels handled.

After 2007, the operation became self-sustainable. Veolia Transport committed itself to managing the Elcidis UCC through its subsidiary Proxiway, which oversees two other services: Liselec (self-service electric vehicles managed by the Urban Community of La Rochelle) and an electric shuttle between the park-and-ride and the town center. This new management model seemed interesting due to the possible synergies between urban transport services for passengers and goods operated by Proxiway in the same town, as it generates considerable economies of scale. Proxiway found itself in a position to reduce its service production costs, otherwise known as “services marketing,” by widening its range of services (joint production). This was possible because Proxiway can now use the same facilities and personnel in La Rochelle to produce several services, and spread its fixed costs (such as rent for the premises) over a larger number of products (Trentini, Gonzalez-Feliu, & Malhence, 2015, p. 9).

A new traffic regulation was imposed that limits the access of heavy freight delivery vehicles with gross vehicle weight (GVW) over 3.5 tons (7,000 lb.) delivering to the city center to between 6 and 7:30 am (ELCIDIS, n.d.). Deliveries were made by eight electric vans. They were well suited



Source: Trentini et al. (2015)

Figure 5: Elcidis UCC Management Model



Source: (Vermie, 2002)

Figure 6: Elcidis UCC, La Rochelle

for the narrow streets of the city's historic center. Initially, the UCC focused on delivering parcels, packages, and messages; later, two electric vehicles (EVs) with temperature control were added to deliver perishable goods (Van Duin, Quak, & Munuzuri, 2010). Around 30% of the deliveries to the city center are handled by the UCC. On average, approximately 450 parcels are delivered. The evaluation of the pilot project found that daily delivery time per vehicle decreased about 3 hours (Vermie, 2002). Vehicle delivery trip distance was decreased by 61% (Van Duin, Quak, & Munuzuri, 2010). As the existing public-private partnership contract ends in 2018, the municipality and stakeholders consider this as an opportunity to develop a more comprehensive strategy for the delivery sector through the production of a Sustainable Urban Logistics Plan (SULP) since the operation of Elcidis UCC has recently become less sustainable (URBACT & Freight TAILS, 2018).

Elcidis at La Rochelle has been considered successful and one of the most popular UCC examples. Van Duin et al. (2010) considered the shared sense of urgency among stakeholders, funding supports, and stakeholder involvement at a very early state as success factors.

3.2.2 Bristol Urban Consolidation Center, UK

Bristol is a large city with over 400,000 population. Bristol UCC is in the city outskirts close to the M4 and M5 motorways and 25 minutes from the Broadmead district (Allen, Browne, Woodburn, & Leonardi, 2014). At the inception, the UCC had floor space of 500 m² (5,382 sq. ft.). Since its inception in May 2004, the UCC has been managed by DHL Exel. According to a 2013 press release from DHL Exel, it serves 115 businesses in the area (DHL Express, 2013). Most participants are medium-sized retailers—telecommunications, fashion, perfume, body shop (Van Duin, Van Dam, Wiegman, & Tavasszy, 2016; Katsela, 2018). The primary objective was to reduce goods vehicle activity in the central



Source: TransportXtra

Figure 7: Bristol UCC delivery truck

retailing area to relieve congestion, improve air quality and minimize conflicts between delivery vehicles and other road users near loading areas/delivery bays. Another objective was to provide suppliers and retailers with improved logistics services, removing the need for suppliers to send their vehicles into the city center, increasing delivery reliability and offering a range of value-added services such as pre-retailing, remote storage, and packaging and waste collection.

During the trial period (2002 – 2006) the European Commission's CIVITAS VIVALDI project provided funding (VIVALDI-CIVITAS, 2006). Bristol City Council provided subsequent financial support. Roughly 40% of operational costs were covered by charges paid by users by around 2009. Over time, attracting more users and selling more value-added services has progressively reduced the dependence on public funds for the UCC operation. As the UCC was perceived as successful, the service area was expanded to Bath, a historic city located 20 km from Bristol. While detailed financial information from DHL is not available, the steady reduction in public funding support and the continuing operation of the UCC suggests that revenue from the users has grown over time and that profits are considered at least satisfactory from a business perspective. While using the UCC is voluntary, the local transportation authority favored UCC vehicles with a rule that allowed UCC vehicles to access bus lanes to cut delivery times and improve delivery reliability.

According to Allen et al. (2014), after implementing the UCC, delivery trips to participating retailers were decreased by 77%, which is the equivalent of a total annual reduction of approximately 10,000 delivery trips and resulted in an annual saving of 250,000 vehicle kilometers traveled (roughly 155,343 miles). Moreover, a decrease in delivery trips and distance helps improve air quality. The UCC operation reduced NO_x emissions by 1,000 kg (2,205 lb.) and PM₁₀ by 30 kg (88 lb.). DHL claimed that CO₂ emissions decreased by 130 tons using two electric, zero emission trucks. Also, it claimed they made 100% on-time delivery to receivers (DHL Express, 2013; Browne, 2014).

While the scheme has been successful in operational terms since it was initiated, it has taken time to enhance its commercial viability, and this has mainly been built on additional retailers joining the scheme and identifying new sources of revenue from pre-retailing activity (Allen, Browne, Woodburn, & Leonardi, 2014).

3.2.3 Meadowhall Consolidation Center, Yorkshire, UK

The Meadowhall consolidation center (MCC) was opened in 2006. Meadowhall is one of the largest shopping centers in the UK, attracting 25 million visitors per year. The consolidation center is adjacent to the M1 motorway on the edge of the City of Sheffield (Clipper). The consolidation center is located on the perimeter of the shopping center. Compared to the above UCCs, the Meadowhall consolidation center was initiated by a private company, British Land, with no public subsidies. Thus, its primary objectives are oriented toward retailers. Its operational scheme has a strong supply chain focus, aiming to add value to the retailers' trading experience through

achieving operational cost savings and greater buying power (Allen, Browne, Woodburn, & Leonardi, 2014). The specific objectives are to permit retailers to increase their sales floor area (by removing the need for storage area within the retail space); help retailers to maximize sales through stock availability and product range; help retailers to reduce freight transport and staffing costs; allow retailers' staff to focus on dealing with customers; and reduce or prevent theft of stock. (Allen, Browne, Woodburn, & Leonardi, 2014). The operation is carried out by a neutral carrier. Until 2006, the consolidation center was managed by Exel Logistics; now Clippers Secure Logistics is managing the facility (Figure 8). It is a voluntary scheme, so there is no compulsion for retailers to channel their goods through it, nor are there any penalties for, or restrictions on, deliveries that are made directly to retailers' premises. Through consolidating goods, the number of delivery trips was reduced by 65%.



Source: www.clippergroup.co.uk

Figure 8: Carrier trucks & promotion phrase

According to the managing firm, retailers' costs of using the UCC can be recovered through store cost savings, increased sales and reduced product losses. A baker achieved a 10% increase in sales of confectionery through increasing product ranges. A fashion retailer experienced increases in sales for three days prior to Valentine's Day due to receiving replenishments twice per day from the UCC. Another fashion retailer reduced theft of goods by 70% by using storage space in the UCC rather than in the store. A food and non-food retailer enjoyed a 4% increase in sales by using the seasonal storage facilities available at the UCC. Another retail outlet that does not open until 10am had previously been forced to accept its delivery

at 6am, meaning that staff had to be provided at that time to receive the goods. By using the UCC, the delivery could still be made in the early morning, but not forwarded to the retail outlet until staff were available in store, thus saving wage costs. (Allen, Browne, Woodburn, & Leonardi, 2014). In addition, the UCC provides additional value-added services to ensure more revenue: storage service such as providing an off-site stock room; stock room management; retail furniture and fixtures storage; and peak and seasonal storage facilities. Pre-retail services include: hanging goods after unpacking; relabeling of goods ready for the shop floor; pressing services; RFID/security tagging; and label printing. It can also handle store recalls and returns and provide staff training facilities. Retailers can pick and choose the services that suit their needs.

3.2.4 Cityporto, Padua, Italy

Cityporto was opened in 2004. Unlike previous examples, it is based in the Interporto (freight village) located outside the city of Padua. It was initiated as a public-private partnership (PPP) with objectives of decreasing customers' driving by 727,920 km (452,309 miles) and reducing congestion by many delivery vans in the narrow streets (BESTFACT, 2016). Major stakeholders are the local public bodies such as the Municipality of Padua, the Chamber of Commerce and the Regional Authority (Vaghi, Oesterie, Siciliano, & Grea, 2014; BESTFACT, 2016). The center is managed by a neutral body, Interporto di Padova SpA that is part of the PPP. Fifteen carriers are delivering goods to Cityporto.

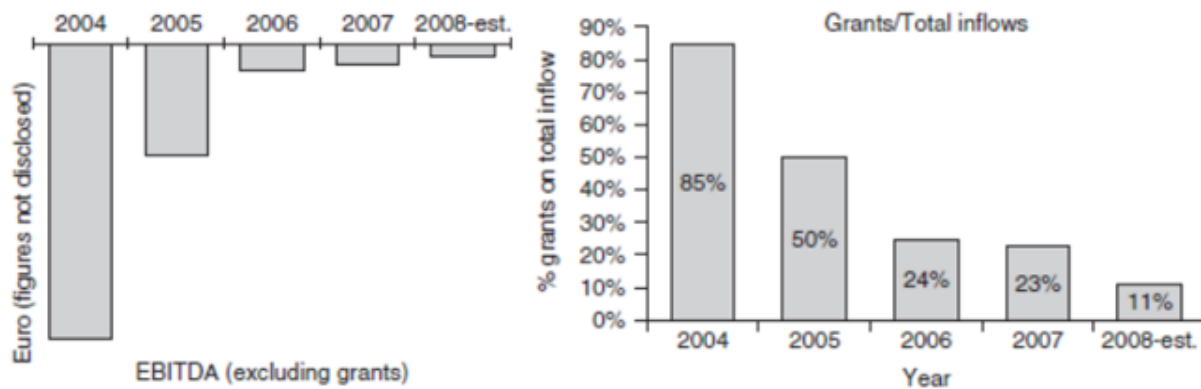


Source: (Vaghi, Oesterie, Siciliano, & Grea, 2014)

Figure 9: Cityporto delivery truck

Subsidies in the start-up phase (2004-2007) were provided by the City and the Province of Padua, and local Chamber of Commerce, as stated in the Framework Agreement (Vaghi & Percoco, 2011). The Agreement granted Cityporto vehicles 24-hour access to Limited Traffic Zones in the city center, use of bus lanes and use of reserved loading space. The amount of grants agreed upon was decreased year by year. As shown in [Figure 10](#), public grants on total inflows have decreased from 85% in 2004 to 11% in 2008. According to recent studies, it has become free of public subsidies. "The practice has proven feasible and financially self-sustainable after a medium-long period [as of 2012], providing considerable and measurable positive effects on traffic congestion and pollution." (BESTFACT, 2016). It has achieved a financial self-sustainability that allows them to plan the development into new areas of activity (Vaghi, Oesterie, Siciliano, & Grea, 2014).

A 2016 BESTFACT case study stated that "the adoption of Cityporto service has so far proven its effectiveness in reducing congestion, energy consumption and pollution deriving from freight traffic in Padua urban area" (BESTFACT, 2016). Cityporto dealt with about 60,000 deliveries annually. Thanks to consolidated deliveries, during the first 15 months vehicle kilometers traveled by customers dropped by 77% or 561,433 km (348,858 miles). In addition, air pollutants emissions decreased by a lot: CO₂ (219 tons), NO_x (369 kg), SO_x (72 kg), VOC (210 kg), and PM₁₀ (51 kg). For the first five-year period, the estimated economic value of environmental benefits has been estimated to double the amount of subsidy for the project.



Source: (Vaghi & Percoco, 2011)

Figure 10: Cityporto Padova grant/inflows ratio, 2004-2008

Cityporto UCC is considered one of the most successful experiences of city logistics (Vaghi, Oesterie, Siciliano, & Grea, 2014, p. 21). Its business model has been replicated in other medium-sized Italian cities. One of the success factors is that the UCC is located within the well-established freight village already well-known among stakeholders (BESTFACT, 2016). Financially the Framework Agreement made the operation of the UCC and a financial picture predictable by determining at earlier state: start-up subsidy until reaching sustainable state. In the planning and start-up phase, it is fundamental to have a continuous contact with the stakeholders and public associations and establish regular city freight committees/technical meetings. (Vaghi, Oesterie, Siciliano, & Grea, 2014)

3.3 Lessons Learned: Factors of Success and Failure

This section discusses the factors of success and failure. “Success” and “failure” are not viewed as separate categories. In fact, success and failure factors are mirror images to each other.

3.3.1 Financial Viability

Despite the potential benefits of a UCC, only a few UCCs survived and are still in operation. Katsela (2018) found that the lack of sustainable business models is a barrier to implementing city logistics initiatives in the long run (Katsela, 2018). In other words, one of the main issues that many UCCs could not resolve surrounds the financial viability. Case studies generally agreed that ensuring financial sustainability of a UCC is easier in the case of the facility with a single landlord (Triantafyllou, Cherrett, & Browne, 2014).

3.3.2 Willingness-To-Cooperate among Stakeholders

Most stakeholders in various supply chains are private businesses whose goal is to maximize benefits. Due to stiff competition, they are concerned about the possibility of disclosing business information such as order quantities, products, customers, business models, and know-how (Vaghi, Oesterie, Siciliano, & Grea, 2014). In one of the stakeholder meetings that the author attended, an owner of a carrier business described the consolidation and government involvement as “socialism.” At another meeting, a long-time businessman related to freight terminal operations disparaged the UCC idea by saying “This is America.” While they are probably “extreme” and very “rare” reactions that the author unfortunately encountered, these encounters strongly suggest the importance of knowledge sharing among public and private stakeholders so that they can understand each other’s objectives and find some common ground. In this sense, even involving private sector actors from the very beginning of the UCC planning process would be too late unless mutual knowledge sharing and understanding had already been established in other industry or public sector initiatives.

3.3.3 Existing Business Model

Since the most important goal of running a business is profit maximization, most businesses have probably operated by an optimized process tailored for their own business. For example, large retail chains and big box stores have their own distribution network. The benefits of participating in a UCC may be negligible or incur additional costs.

3.3.4 Compulsory Measures and Favorable Rules

The existence of compulsory measures and single ownership is important for success (Allen, Browne, & Holguin-Veras, 2015). Most UCCs with voluntary participation and with complicated public private partnerships appeared to require public funding, despite the promotion of value-

added services as part of the UCC offer. Allen et al. (2015) suggested making participation prerequisite through planning or lease agreements like the London Heathrow Airport UCC. However, controversies surrounding compulsory measures or regulations do exist. Some argue that access restrictions of heavy trucks to inner city locations combined with a UCC will result in “multiplying the number of small delivery trips which is not really what is best for the environment and the city’s inhabitants” (Vaghi, Oesterie, Siciliano, & Grea, 2014, p. 7).

3.3.5 Demand of Private Sector Stakeholders

The number of participants is probably the most important success factor. Enough potential UCC users and product throughput are required to drive down the costs per unit handled, thereby making the UCC competitive with traditional urban distribution systems (Van Duin, Quak, & Munuzuri, 2010).

The second most important success factor is the sharing of UCC costs and benefits among the various supply chain parties involved in the scheme. (Allen, Browne, Woodburn, & Leonardi, 2014)

Low- or zero-emission vehicles and ICT platforms are almost entirely funded by public grants in Italy (Vaghi & Percoco, 2011).

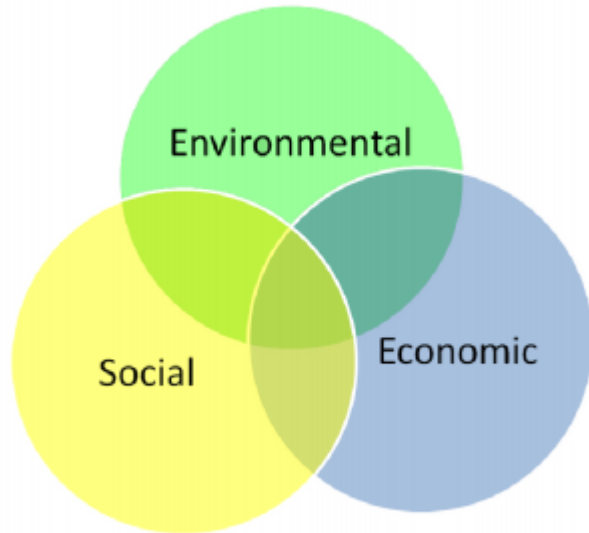
3.3.6 Clear Long-Term Vision Based on Mutual Understanding

One of the primary success factors for the Cityporto UCC was that the public sector and the private third-party operator had a clear long-term plan with the Framework Agreement. After eight years of operation with subsidies that had been gradually reduced, the UCC became self-sustainable. This is one of the best examples of a successful medium-long period plan.

4.0 GAPS IN SUSTAINABILITY GOALS

This section summarizes the outcome metrics of the four case studies in terms of the three pillars of sustainability (Figure 11). The phrase “the three pillars of sustainability” is “a powerful tool for defining the complete sustainability problem” (Thwink, n.d.). The three pillars are not mutually exclusive; rather there some overlapped dimensions by generating direct and indirect impact of human activity. “If any one [of the] pillar[s] is weak then the system as a whole is unsustainable” (Thwink, n.d.).

Table 1 is a summary of the four case studies in Section 3. In the bottom of the table appear various benefits of UCC implementation. Due to the limited availability of quantified UCC evaluation metrics, it is not possible to compare them in a more robust way. First, as promised, the number of truck trips and distances decreased significantly. In Elcidis UCC, each delivery vehicle could save three hours per delivery and reduce total distance by 61%. In the case of Bristol UCC, DHL Excel, the UCC operating company, claimed that they have achieved 100% on-time delivery. Also, the number of trips decreased by 65% in Meadowhall UCC. The significant reductions in delivery frequency, total truck miles traveled, and delivery time can be translated into a significant direct and indirect reduction in congestion, emissions, noise, safety concerns, and adverse health impacts. The amount of air pollutants such as NO_x, CO₂, SO_x, and VOC decreased. It should be noted that CO₂ is the major source of greenhouse gases. In 2016, CO₂ was responsible for 81% of the greenhouse gas emissions (Environmental Protection Agency, n.d.).



Source: (Environmental Protection Agency, 2015)

Figure 11: The three pillars of sustainability

Table 1: Summary of Case Studies

	Elcidis	Bristol	Meadowhall	Cityporto
Start	2001	2004	2006	2004
Financial sustainability	Yes, since 2007	No	Yes	Yes, since 2011
Initiator	Public	Public	Private	Public-private partnership
Service area	City historic center	Shopping mall	Shopping mall	City center
Primary objectives	Promoting delivery by EVs	Decreasing total delivery trips	Add values to the retailers	Decreasing delivery trip distance
	Goods distribution optimization Congestion relief	Congestion relief Air quality improvement Improved logistics services		Congestion relief
Subsidy	2001-2006 during pilot	2002-2006 during pilot; Then Bristol City Council, gradual decrease.	No	2004 – 2011, gradual decrease until self-sustainable
Owner	Public	Public	Private	Public
Operator	3 rd party (neutral) carrier	3 rd party (neutral) carrier	3 rd party (neutral) carrier	3 rd party (neutral) carrier
Compulsary or favorable regulations	Access restriction with time window and GVW limit	Use of bus lanes		24 hour access to city center, bus lanes, reserved loading space
Participation	Voluntary	Voluntary	Voluntary	Voluntary
Outcome Metrics				
Delivery time	3 hour reduction/vehicle	100% on-time		
Trip Distance	61%	77%		77%
Nox		1,000 kg		369 kg
PM10		30kg		51 kg
COs		130 tons		219 kg
SOx				72 kg
VOC				10 kg
Trips			65% reduction	
Economic benefits			Baker: 10% sales increase Fashion retailer: Theft decrease by 70% A food and non-food retailer: 4% sales increase by using seasonal temporary storage	Estimated economic value of environmental benefits twice the subsidy amount

5.0 DISCUSSION: THE RATIONALE OF SUPPORTING SOCIAL SUSTAINABILITY – FOOD DESERTS

It appears evident that UCCs generate positive externalities. However, it was not clear whether studies have been conducted and reported UCCs' positive externalities in terms of improving social sustainability. While some aspects of social sustainability, such as public health and the quality of life, are affected by the environmental and economic sustainability, a clearer discussion of UCC's benefits on social sustainability needs to be considered. As was already quoted above, *"If any one [of the] pillar[s] is weak then the system as a whole is unsustainable."*

With that said, the author suggests applying the lessons of implementing UCCs and models of city logistics to improve one of the serious equity issues: food deserts. The rationale is simple enough for probably all planners to know in a theoretical sense. The case studies and review of recent literature indicate that making a UCC financially sustainable is the most difficult task in beginning a UCC discussion. It seems there are several strong cases for not planning UCCs both from the public and private sectors' perspectives, as many studies suggested—e.g., Allen et al. (2015), Bjorklund and Johansson (2018) among many. First, the most effective and efficient type for a successful UCC is one owned by a single landlord and managed by a neutral carrier. Second, a majority of UCC pilots could not survive because subsidies were discontinued. Third, many UCCs had trouble in attracting enough number of participants to operate the UCC in a financially sound way. Fourth, while objective evidence was not provided, Giuliano et al. (2013) concluded that UCC schemes' chance of success in the U.S. is low.

With that said, it was suggested that the planners remind themselves of the goal of public policy. It is an efficient and effective allocation of limited resources—our tax dollars—in order to achieve the maximum social welfare. If benefits from positive externalities are so large, there is a merit for the public sector to contemplate UCCs. Since financial viability always will be a challenge, the author suggests the government can plan and implement a UCC with public subsidies to improve social welfare such as equitable access to fresh food.

The lack of access to fresh foods within reasonable distance and at affordable prices has become a public health concern for individuals living in underserved inner-city communities and remote rural areas. Such areas are generally called food deserts. The Food and Nutrition Services (FNS) of the U.S. Department of Agriculture (USDA) defines a food desert as *"a low-income census tract where either a substantial number or share of residents has low access to a supermarket or large grocery store"* (U.S. Department of Agriculture, n.d.). A low-income census tract is where more than 20% of residents earn income at or below the federal poverty level for family size, or at or below 80% of the surrounding area's median family income. Tracts in urban areas qualify as "low access" tracts if at least 500 persons or 33% of their population do not have a supermarket or large grocery store within one mile of their residence. The distance threshold for rural areas is 10 miles.

While location decisions of existing grocery stores were based on the profit maximizing economic principle, system inequity in lower accessibility to fresh foods has emerged as an unintentional by-product. That is, a food desert is an example of market failure that warrants government involvement to improve equity—in other words, to reduce social costs (e.g., health costs) associated with lower consumption of fresh foods.

A preliminary study has been conducted by the author³. The goal of the study is to develop a last-mile fresh food delivery system for individuals in underserved communities with food deserts. While the study is still in progress, a few macro-level network models were developed, and a sensitivity analysis has been conducted. Delivery routes by trucks, e-bikes, pick-up buses, parcel lockers, and pop-up trucks were mathematically formulated. Preliminary results show the potential of implementing a UCC for door-to-door fresh food delivery for residents in food deserts. One may argue that existing large grocery stores and third-party logistics carrier like UPS could serve those neighborhoods. However, since many food deserts are located near or within locations with high crime rates, grocers and other carriers are not willing to make such door-to-door deliveries.⁴ This is where the public sector steps in and helps the underrepresented.

³ This study is finalizing, but not publicly available yet. The study information can be found at the website of the National Transportation Center at Morgan State University (www.morgan.edu/soe/ntc).

⁴ This is based on personal discussions with relevant planners.

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