Proceedings of 7th Transport Research Arena TRA 2018, April 16-19, 2018, Vienna, Austria

Urban Freight: What about construction logistics?

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Abstract

This paper aims to improve the knowledge and understanding of urban freight distribution related to the construction sector. The contribution highlights the specificities of the chain which supplies construction sites in urban areas as compared to other, well studied, supply chains such as retail, HoReCa (hotels-restaurants-cafes) and home deliveries. The paper also tries to identify the barriers against and the triggers towards a more sustainable urban freight transport for the construction sector. In conclusion, experiences from the ongoing CIVITAS Horizon 2020 project "SUCCESS", aiming at identifying the costs and benefits associated with the introduction of a number of optimization strategies, including but not limited to Construction Consolidation Centres, are used to identify potential ways to make urban construction logistics more sustainable.

Keywords: last mile; construction city logistics.

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1. Introduction

Urban freight transport (UFT) plays an essential role in the functioning of cities, but at the same time generates significant nuisances such as congestion, noise and air pollution. A lot of attention has been paid in the last years to UFT in general and to specific supply chains such as retail or e-commerce, while too little attention has been paid to the supply chain of the construction sector.

Due to the increasing urbanisation (United Nations, 2014), the need for new or renovated constructions is growing and results in an increase of UFT operations related to the sector. Every day in cities, vehicles enter and travel in congested urban areas to provide building materials to construction sites and to take away waste materials for disposal. According to Dablanc (Dablanc, 2009), building materials can make up to 30% of the tons carried across cities in growing urban areas. Considering the significant part that the transport of building materials, construction waste and equipment accounts for, efforts are needed to further study the construction supply chain. A better knowledge and understanding of the main characteristics of the goods flows is a prerequisite for defining successful logistic strategies, either from the perspective of local authorities, construction companies, or transport & logistics actors, and for implementing adequate actions.

A recent article from The Economist ("The construction industry's productivity problem And how governments can catalyse change," 2017) shows that the construction sector, when compared to the other economic sectors, suffers from a poor productivity performance. While the productivity per hour of the manufacturing sector has increased by almost 100% since 1995, the productivity in the construction sector has not grown by 20% for the same period. The contribution highlights the specificities of the chain which supplies construction sites in urban areas as compared to other well studied urban supply chains such as retail, hotels restaurants and cafes (HoReCa) and home deliveries.

The underlying research question is: "What are the specific characteristics of the construction supply chain when compared to more frequently studied urban supply chains?". The paper tries to also identify the barriers against and the triggers towards a more sustainable UFT for the construction sector. The works are performed within the SUCCESS project. The European Sustainable Urban Consolidation CentrES for conStruction project (SUCCESS) aims to improve the efficiency and reduce negative impacts of the construction supply chain by exploring and testing reliable and innovative solutions.

2. Methodology

A literature review and a quantitative analysis of logistics operations in four construction sites located in diverse urban areas across Europe are conducted to identify urban logistics patterns with regards to stakeholders, nature of transported goods, types of vehicles, regulations, and so on.

The quantitative analysis is based on data collected during the SUCCESS project. For the purpose of understanding urban construction logistics flows, 4 construction sites were observed daily over 8 months between Q4 2015 and Q3 2016. During this period, dedicated persons on each of the four construction sites manually collected data representing a total of 4436 deliveries and pickups trips records. Each construction site had its specificities in size and nature of construction works, and each was located in a different urban area and in a different European country (Paris in France, Luxembourg-city in Luxembourg, Verona in Italy, Valencia in Spain). For each construction site, the collected data were related to the material delivery and waste pickups trips' locations (starting location, final location, locations preceding and following the site delivery/pickup in case of a roundtrip), trips' transit times (start, arrival in city, arrival at site, unloading/loading, departure), material delivered or picked up (nature, weight, volume, packaging, amount), loading/unloading conditions (handling equipment, number and role of persons required for unloading), vehicles characteristics. The quality of collected data was regularly assessed during the observation period and corrective actions were put in place to ensure the consistency of the data collected among sites and all along the time period.

Thanks to the length of the observation period, the diversity of data collected and the diversity of observed cases, we assume that the collected data are representative enough of construction logistics activities in European cities, so as to compare urban construction logistics activity with more traditionally studied urban logistics activities. When figures are provided for a specific city with regards to frequently studied urban supply chains, UFT surveys show that if not strictly equivalent, the figures for each indicators have the same order of magnitude (BESTUFS II, 2006; Dablanc, 2011; Ogden, 1992). So comparing indicators of frequently studied urban supply chains of one specific city versus indicators for urban construction supply chain, is not correlated to the city and the comparison can be generalised to European cities globally speaking.

3. Comparative analysis

UFT is complex, diverse and fragmented. A city is supplied by hundreds of supply chains, one for each economic sector (Gérardin et al., 2000). UFT can be categorised in two functional classes: 1) consumer-related distribution including retail, food and home deliveries and 2) producer-related distribution including construction materials, waste and industrial goods (Rodrigue and Dablanc, 2017; Visser et al., 1999).
Construction sector shares similarities with both industry and service sectors. One the one hand, construction sector as a place of production requires a lot of goods such as the industry sector. With the urban sprawl, several economic sectors, including the industry, tend to move away from urban areas towards more suburban areas (Dablanc and Rakotonarivo, 2010). However this option is not possible for the construction sector, since buildings or works (as products of the construction activities) cannot be distributed once constructed. This characteristics makes, in a sense, the construction sector sharing with the services sector the fact that products are consumed at the time and on the place they are produced. Then from a "producing sector" point of view, only services and construction sectors remains in dense urban areas. As the service sector does almost not require materials or goods to produce its results, it tends to be ignored in UFT studies. As a consequence UFT studies focus more on consumer-related distribution (where the activity is more visible and more diversified) than on producer-related distribution.
In the remaining of this section we thus compare the UFT for construction as an example of producer-related distribution, to frequently studied UFT focused on consumer related-distribution. To do so, we use five main points of view: stakeholders of the supply chain, vehicles used in the supply chain, organisation of the deliveries, material used for goods unloading and handling, and policy measures related to UFT.

3.1. Stakeholders

Frequently studied urban supply chains are organised around four key stakeholders: shippers, freight carriers, residents (end-receiver) and public authorities. Fig. 1 shows the interrelationships among those stakeholders. Basically, the relation is between the shippers who provide goods to the consumers with the support of the freight carriers. The planners and regulators set the rules in the environment which the UFT is operating in (Crainic and Montreuil, 2015; Taniguchi et al., 2001; Taylor, 2005; Visser et al., 1999). Each of these stakeholders has different expectations sometimes conflicting with other stakeholders expectations (Macharis and Melo, 2011).

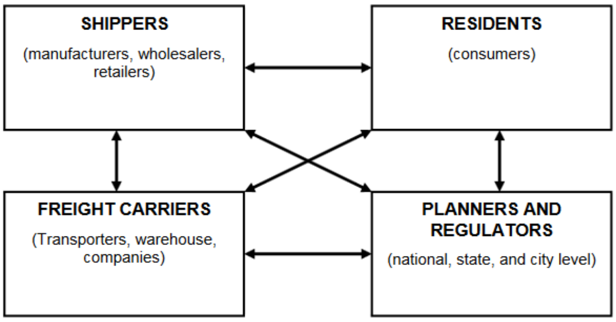

Fig. 1 Key stakeholders in UFT source: (Taylor, 2005)

This organisation model reflects the consumer-related distribution perspectives. When transposing it to the construction sector, as a producer-related distribution chain, the interrelationships varies. Suppliers (shippers) provide construction materials to all contractors responsible for their work package (consumers). Transport activity is usually operated by the supplier who delivers itself the goods (own account transporter). The planners and regulators remain similar to the consumer-related distribution but the introduction of a main contractor adds an additional level of complexity in setting the delivery rules on the site (CIVITAS, 2016).

3.1.1. Consumers (contractors)

The construction is unique in the sense of it is one-of kind nature of projects, site production and temporary multi-organization (Koskela, 1992). Indeed, the construction project team is rarely made up of a single organization but rather a main contractor and subcontractors specialized in their areas of expertise who join temporary their effort to meet the contractual requirements. Commonly, the organizations do not work at the same time on the construction site. They produce their work according a pre-defined planning and intervene when necessary. At the end of the project, all the construction team separate. The literature highlights the importance of partnering relationships and collaboration (Bygballe et al., 2010) and consumer-related distribution tend to collaborate on a long-term basis. But in the construction sector, the temporariness of the supply chain and the tendering procedures makes long-term partnership difficult. In the construction sector, supply chain actors can face several issues that are very specific to the activity and to the nature of the goods receiver. First, with regard to the receiver location, even if customer and supplier may have a long collaboration record, the receivers' locations change frequently (at each new construction sites). Therefore, traditional tools and processes for supply chain management need to be adapted. For example a delivery addresses database would need to be updated more frequently than in other urban supply chains. In addition, for some delivery or pickup locations, the address may even not exists since the buildings (or streets) are still under construction and are then not yet recorded in official registries. If the construction site is embed in a whole district under construction, it may even be more complex to find the precise location and the access path to the location. Last from a receiver perspective, the person in charge of validating a delivery is often busy on other tasks at specific and changing places on the site where he/she may have delays in his/her tasks. In case of delays also on delivery / pickup operator, both the time and spatial synchronisation required for the validation of the delivery will be harder to find than in more classical supply chains.

3.1.2. The main contractor is an additional actor in the supply chain

The main contractor is responsible for the overall coordination of the construction project and has to follow the day-to-day operations to coordinate the various stakeholders' activities at the construction site. It has a direct impact on the delivery schedule. The main contractor has a limited vision of the supply chain due to the wide variety of actors: each sub-contractor is responsible for ordering materials needed but cannot schedule independently the deliveries on site. Thus the stakeholders have to synchronise with the main contractor for scheduling their material deliveries on the site.

3.1.3. Shippers (suppliers)

For the same reasons as described for the "contractors" stakeholders, it is more difficult for shippers of the construction supply chain to establish long-term partnerships. As an example, suppliers of a construction site change frequently because the material requirements vary along the project and between sites.

3.1.4. Freight carriers

The own-account transport still accounts for a significant part of vehicle movement in cities. In Paris Region, it represents 57% of vehicle movements against 43% operated by third party providers (APUR, 2014). The consequences include an increase in pollution, congestion, noise, accidents and poor level of transport activities. Whereas in manufacturing, retail or services supply chains, shippers tend to outsource transport services to a third party, shippers in construction (often material suppliers) rely mainly on own-account transport.

Because the warehouses tend to move away from urban areas, the distance over which vehicles are travelling to make urban deliveries has increased substantially. The trip length varies according to the city, the type of vehicle and the type of operator but the average trip length approximates 50 km in London, France and Bologna (BESTUFS II, 2006). SUCCESS observations show for the observed construction sites an average trip distance ranging from 66 to 350 km, with a median trip distance ranging from 10 km to 250 km. The delivery trips distance is highly variable among the site and even within a same construction site.

From a stakeholder perspective, the fragmentation of the construction sector resulting in a lack of supply chain visibility and less consolidation opportunities is the main barrier against a more sustainable UFT.

3.2. Vehicles

3.2.1. Types of vehicles

Since businesses are supplied just-in-time and have minimal storage space for deliveries, the urban freight distribution generates high frequency deliveries and smaller volumes (Rodrigue and Dablanc, 2017). Light goods vehicles (LGVs) and medium-sized vehicles are largely used (Macharis and Melo, 2011). LGVs tend to be more adapted and popular to deliver in urban areas (Browne et al., 2010). LGVs operate for 71% of the deliveries in Mexico (Lozano-Cuevas et al., 2006) and 61% in Paris Region (Enquête Transport de Marchandises en Ville - Région Île-de-France, 2014). Heavy goods vehicles (HGVs) including semi-trailers and trucks with a trailer also operate in urban areas but in lower frequency. They deliver mainly sites which benefits from their own loading facilities such as supermarkets. Construction sites are also generally delivered by heavy trucks that damage roads (Dablanc, 2011). SUCCESS observations show that heavy trucks are used for deliveries in a large to very large majority. Indeed, three out of the four sites count between 95% and 100% of deliveries with HGVs and only 0% to 5% of deliveries with LGVs. The remaining site counts 2/3 of deliveries with HGVs and 1/3 with LGVs.

3.2.2. Access to the vehicle load

The doors of a delivery vehicles are opened and closed a number of time over the trip. For this reason, vehicles manufacturers propose rear doors and sliding doors to load and unload the goods from LGV. Medium-sized vehicles and HGVs operating in urban area are equipped with tail lift to unload pallets, because usually no dock is available at the delivery point. In construction, to access the load quickly and easily, curtains replace the sliding doors on HGVs. Some vehicles are accessible by the top so that a crane can directly unload the materials from the vehicle and transport them closest to the final point of use either on the roof or into floors via an access platform limiting thus the number of handling movements.

The preference for delivering with HGVs is an opportunity for consolidating and reducing the environmental impact of the UFT. But, the nature of goods and unloading constraints require specific delivery vehicles which are not fit to deliver other sectors neither to support load consolidation with other supply chains.

3.3. Delivery

3.3.1. Organisational mode

Delivery vehicles can either perform a direct trip (single-drop trip) or multi-drop round. Direct trips involve the vehicle delivering the entire load to one receiver (i.e. there is only one delivery point) while multi-drop rounds involve the vehicle delivering the load to deliver several receivers (i.e. there are more than one delivery point). Urban deliveries are mainly organised in multi-drop rounds. On average, they account for three quarters of the number delivery trips and count from 15 to 18 delivery points (APUR, 2014; Dufour et al., n.d.; LIST, 2014). Urban deliveries to construction sites are mainly organised in direct trip. Delivery trips of the four construction sites observed in SUCCESS are single-drop rounds in 97% of the deliveries.

3.3.2. Scheduling of deliveries

Traditional deliveries can either be scheduled (i.e. planned in advance and regular) or ad hoc (i.e. unscheduled). An UFT survey in UK shows that goods receivers operate with regular delivery (Allen et al., 2008).
Since the Just-In-Time philosophy advocates the elimination of non-value adding activities, deliveries in a lean approach arrive on construction sites within a scheduled delivery slot, convenient to the construction operation and in line with their build plan (Lundesjö, 2015). The literature review shows the specificities of deliveries to construction sites in urban areas (Allen et al., 2014; Browne et al., 2005; Ville et al., 2010). Some construction companies plan their deliveries on a fixed delivery time, others within a delivery window and lasts ones use both approaches. SUCCESS observations show that time window is scarcely used for delivery scheduling. Indeed more than 70% of scheduled deliveries observed in SUCCESS use a fixed time point for delivery scheduling whereas less than 30% of use time window. When used, the size of the window allowed to delivery is 3 times out of 4 a 30 minutes slot, and 1 out of 6 times a delivery window longer than 4 hours.

3.3.3. Delivery time

The majority of the urban deliveries tend to take place in the morning (i.e. from 6AM to 12AM) whereas pick-ups are more spread throughout the working day. Night time deliveries remain marginal (Allen et al., 2008; BESTUFS II, 2006). This does not vary for the construction sector. SUCCESS' observations show that 2/3 of construction material deliveries happen before noon and 80% before 2PM. Only 20% of deliveries happen after 2 PM and only 1% of deliveries after 6PM.

3.3.4. Duration of stops

In commonly studied urban freight, delivery operations are relatively short. According to several UFT surveys in Europe, the durations of stops last on average 10 to 15 minutes (Dufour et al., n.d.; LIST, 2014; Macharis and Melo, 2011; Patier, 2011). The duration of the stop increases with the quantity of goods delivered and therefore with the size of the vehicle. A HGV delivery stop lasts on average 20 to 40 min (Cherrett et al., 2012; *Enquête Transport de Marchandises en Ville - Région Île-de-France*, 2014). SUCCESS' observations confirm this trend. On average, a (HGV) delivery vehicle stops for 74 minutes, of which 45 minutes are used for unloading the material, the remaining 29 minutes being waiting time for various reasons (Colin et al., 2017).

3.3.5. Delivery frequency

The number of movements (i.e. deliveries, pick-up or mixed operation) varies widely depending on the industry category of the receiver, the nature of the premises (store, office, warehouse…) and the number of jobs (Ambrosini et al., 2013). As an example, independent retailing stores are supplied three to ten times a week (Dablanc, 2011).

SUCCESS' observations show that in average a small construction site counts 12.5 deliveries per week, whereas a middle-sized construction site counts 25 deliveries per week, and a large urban construction site counts 50 deliveries per week.

3.3.6. Operation type

Cities are places for consumption where the number of deliveries remains more significant than pickups (Gérardin et al., 2000; Rodrigue and Dablanc, 2017). The proportion between deliveries and pickups is relatively similar between cities. In Paris Region, deliveries represents 63% of the vehicle movements and pick-ups 37% (APUR, 2014). In Bordeaux, Marseille and Dijon, deliveries represent 61% of the operations and pick-ups 39% (BESTUFS II, 2006). In Luxembourg, deliveries represent 77% of the operations, pick-ups 10% and combined 13% (LIST, 2014). SUCCESS' observations show no significant difference since 66% of recorded vehicle movements are deliveries while 33% are pickups.

3.3.7. Delivery point

In urban retail, HoReCa or services deliveries, the usual delivery point is either the receiver's storage room or floor space or the place of truck unloading, the unloading bay (Allen et al., 2008, p. 47). SUCCESS' observations show that, for two construction sites, the material are delivered at the loading/unloading area of the construction site. Then the construction teams are in charge of moving the material at the storage area or at the point of use. However for one site, the material are delivered directly to the storage area near to the final point of use.

From a delivery efficiency perspective, the fragmentation of the construction sector is again a barrier to consolidation opportunities. The lack of coordination, communication and information and communication technologies (ICT) explain also the poor performance of sector's deliveries.

3.4. Material

3.4.1. Unit load

Although goods can be delivered in various packaging, different UFT surveys (Allen et al., 2008; Debauche, 2006; LIST, 2014) suggest that boxes packaging is used in a range from 50 to 75% of the deliveries. Pallets can represent up to a third of the deliveries. Little use of roll cages, hanging rails are observed. According to SUCCESS pilots' observations, almost half (48%) of material deliveries on construction sites use pallets whereas 14% of deliveries use boxes, 7% racks and the remaining are unit deliveries.

3.4.2. Goods handling

Because most of the deliveries use boxes as packaging for goods, boxes are usually either carried by the driver into the establishment or, if heavy or numerous, transported with a trolley. Around 50% of the deliveries are operated by hand (Ambrosini et al., 1999; LIST, 2014). In a lower extent, deliveries using roll containers or pallet truck are observed when specific packaging type require the use of such special equipment. For construction sites, the delivery driver unloads mainly with the equipment available on the site rather than its own equipment. Some vehicles are equipped with a crane or another handling equipment. According to SUCCESS observations, on one site, the construction crane is used for half of deliveries, whereas delivery trucks' own equipment are used for 30% of deliveries. For a second site, forklift is used for almost half (47,6%) of deliveries, whereas handling equipment of the site (crane or lift) are used for 39% of deliveries and the remaining deliveries used a combination of both (usually forklift and construction lift). For a third site, the forklift is used for more than 2 deliveries out of 3 (68%), and the site crane is used for 22% of deliveries, the remaining deliveries use specific equipment (concrete pump).

3.4.3. Material storage

Space is a limited key resource in urban areas. The high land prices encourage the receivers (retailers as well as construction companies) to limit storage space so as to exploit the available space for commercial or productive use. If short-term storage is necessary, commercial establishments benefit usually from an indoor fixed storage capacity in time and space while storage capacity on construction sites varies in time and space. Depending on the type of material, storage areas can be located inside or outside the building and will move with the construction progress. Next, the receiver's storage facilities will change depending on each construction site and cannot be foreseen. Indeed depending on the building footprint and elevation, the site may require to store the material outside or inside a building (under construction). Some construction projects will have a reduced building footprint with regards to the whole site area and the site will have large storage capacity outside. However in a majority of cases the building footprint will lower the capacity of the site to store delivered material outside and the material will be stored inside the building under construction. In such case additional handling operations will be required to move material. Even the storage capacity and location will vary over the project lifetime. For example, a new construction will start with some storage capacity outside and as long as the building progresses, the footprint of the building will reduce the outside storage capacity, but increase inside storage capacity. Yet, near the end of the project, with finishing works, the inside storage capacity will reduce to avoid damages or dirtiness due to material storage and handling.

3.4.4. Weight

If the precise volume of goods per delivery point is an information hard to find, it is easy to imagine that construction materials delivered to a construction site are largely heavier than other delivery points in an urban area. Building sites are a key segment of UFT because the tonnage they generate counts up to 30 percent of tonnage carried in cities (Dablanc, 2011). SUCCESS observations count a daily average of 8.2 to 10.2 tonnes of material delivered to each construction site.

3.4.5. Volume variability

As one can imagine, UFT experience high peaks of activity during specific periods to meet the seasonal needs, such as Christmas (Allen et al., 2008). On the contrary, construction sector does not have this seasonality as buildings are constructed all year long. Still two factors can affect the construction activity. First some working regulations may imply slowdowns of the activity during specific periods of the year (e.g. collective holidays during summer period). Second, weather conditions may irregularly affect the construction site activity, either in part (e.g. crane unavailability in case of strong wind) or in totality (e.g. showers or frost periods).

There is a clear opportunity to consolidate building materials since most of them are robust products at relatively low cost and with a long lifespan.

3.5. UFT policy measures

3.5.1. Low consideration of UFT in the urban planning process

Although UFT is essential to the functioning of cities and plays an important role within the whole urban mobility system, it is rarely considered in urban planning. The most commonly adopted policy measures tend to restrict rather than assist goods vehicles operations (Crainic and Montreuil, 2015; Lindholm, 2010):

- Vehicle access restriction : delivery time access restrictions (limiting the times at which goods vehicles can enter all or part of an urban area, and the times at which loading and unloading operations can take place) and vehicle restrictions (restricting the size and/or weight of the goods vehicles that can enter all or part of an urban area)
- Utilization of public infrastructure e.g. Parking spaces for unloading and loading freight vehicles

The low level of detailed knowledge and awareness of UFT and particularly of construction supply chains can explain the low integration of these flows within the urban planning. Considering the demand for renovation in urban areas, opportunities for improvement exist and cities should give more priority in their agenda to UFT related to the construction supply chains.

3.5.2. UFT policies less restrictive for construction supply chains

Cities implement UFT policies to reduce the negative effects of freight transport in urban areas and overlook the conflicting objectives and interests of different stakeholders. Classifications of UFT policies differ from researchers (Ogden, 1992; Russo and Comi, 2010; Stathopoulos et al., 2012; Van Duin and Quak, 2007; Visser et al., 1999) but remain similar. Ogden (Ogden, 1992) proposes the most commonly classification of UFT policy and planning as follows: network strategies; parking or loading strategies; location and zoning of land use; licensing and regulations; pricing strategies; terminals and modal interchange facilities. Other strategies can be also considered: traffic information systems, intelligent transport system, electronic toll collection, logistics information systems, vehicle technology improvement and voluntary co-operation.

UFT policy measures are implemented with some degree of differentiation between some supply chains to avoid imposing constraints on vehicles delivering specific types of goods such as construction materials. Therefore construction supply chains usually remains out of scope of many UFT policy measures with exemptions and authorisation/permits for construction material and equipment delivery.

- Network strategies: in Prague, permits can be provided to HGV delivering construction sites to enter the regulated zones limited to circulation of vehicles under 6 tonnes or 3.5 tonnes in the city centre (MDS Transmodal Limited and Research Centre for Transport and Logistics (CTL), 2012).
  In Ljubljana, a permission is provided to construction vehicles to enter the pedestrian areas (Ordinance on Road Traffic regulation, official Gazette of the republic of Slovenia, 2001 art. 27).
- Parking and loading strategies: delivery vehicles in construction do not use loading bays provided by cities because such bays do not fit their needs in terms of required area or proximity to delivery point. For this reason, goods vehicles are not concerned by this strategy.
- Licensing and regulations: in Paris (Ville de Paris, 2006), access restriction on the time and the vehicle surface that exist for "standard" deliveries specifically exempt vehicles delivering construction sites.
- Terminals and modal interchange facilities: the measures included in this class of policies distinguish types of consolidation centres (CCs). It means that flows cannot be managed together easily. We observe two main types of consolidation centre: UCCs mainly for the consolidation of retail deliveries in urban areas and UCCs for the consolidation of construction materials for development sites in urban areas (so called CCCs or Construction Consolidation Centres). This differentiation illustrates again the specificity to address the construction supply chain separately.

For locations and zoning land-use and pricing strategy policy measures, no specificities due to the construction sector urban freight have been found.

3.5.3. Loading areas

In busy urban areas, parking spaces are very limited and carriers often encounter difficulties to find places to stop their vehicles to load and unload safely. Only malls and some shops benefit from their own loading areas. To improve working conditions for transport operators and address the negative impacts that can be caused by delivery operations, cities allocate dedicated, fixed and public space for deliveries operations in areas where frequent freight vehicle trips are observed, such as business districts and retail areas. Although transport operators struggle to find suitable space, they still can park. In the construction sector, the on-street loading areas usually do not exist or do not fit the deliveries operations. Because of the nature of the goods, the transport operators have to deliver as close as possible to the construction site. It implies the main contractor to create off-street loading areas inside the site or on-street loading areas along the fence on a space that the receiver rents from the city. The loading areas on a construction site are temporary and its number varies along the planning. In the construction sector the delivery area is not pre-determined. From observation on SUCCESS pilot sites, the main contractor is in charge to create and manage the delivery areas for the purpose of the construction site. Such delivery area is either a public space rented from the local authority for the duration of the construction project or a dedicated space on its construction site. Drivers that deliver the site for the first time are usually not aware of the arrangements taken by the main contractor for the delivery areas and have usually not specific instruction for the deliveries. Then they have to inquire of such arrangement directly at the site entrance.

Except few initiatives such as the Construction Consolidation Centres in Hammarby and London, we note that usually construction sites are rather considered as a trigger to design UFT policy measures rather than a specific supply chain to regulate. In Bordeaux, Proximity Logistics Spaces was implemented during the redevelopment of the urban area to reduce the constraints related to the construction of the tramway network (Dizain et al., 2013).
The role of the public sector which accounts for almost a third of the total construction spending in America and Europe is paramount to improve the situation, e.g. using procurement to force innovation in construction, including in its supply chain (The Economist, 2017).

4. Results

As a result of our comparative analysis between commonly known urban supply chains and construction supply chains (see Table 1), we note that differences exists for most of the observed characteristics, except for shippers, delivery time, operation type and urban planning characteristics where we do not find significant differences.

Table 1. Specificities of the construction urban supply chains

Characteristic		Commonly known urban supply chains	Construction supply chains
		"Permanent" supply chain	Temporary supply chain
Stakeholders			
	Consumers	Residents	Contractors
		Fixed delivery address	Temporary delivery address

Characteristic	Commonly known urban supply chains	Construction supply chains
Shippers	Manufacturers, wholesalers, retailers	Manufacturers, wholesalers
Freight carriers	Own-account/Third party Short trip length	Own-account Medium trip length
Vehicles		
Vehicle size	LGV	HGV
Access to the vehicle load	Rear and side	Side and top
Delivery		
Organisational mode	Multi-drop round	Single-drop trip
Delivery scheduling	Moderate use, both fixed time and time window	Highly used, mostly fixed time
Delivery time	Mainly during the morning (6-12 AM)	
Duration of stops	Short stop duration (around 15 min)	Long stop duration (around 45 min)
Delivery frequency	3 to 10 deliveries per week	12.5 to 50 deliveries per week
Operation type	2 deliveries for 1 pickup	
Delivery point / Storage	Fixed storage capacity	scalable, temporary and moveable storage capacity
Material		
Unit load	Boxes	Pallets
Good handling	by hand (or trolley)	by crane or forklift
Storage area	Fixed, indoor	Moving, indoor or outdoor
Weight/volume	Highly variable	8.2 to 10.2 tons per day
Volume variability	Due to seasonality	Due to regulation and weather conditions
Policy measures		
Urban planning	Low consideration of UFT in urban planning	
UFT policies		Exemptions for construction
Loading areas (for delivery operations)	Fixed public space provided by cities (loading bays)	Public space temporary rented by main contractor

5. Conclusions

The literature review confirms that few researches are carried on construction logistics and supply chain while the awareness of ways to optimize them is low among professionals from the construction sector. Despite the similarities with other supply chains, the analysis of the construction supply chain shows significant differences in the logistics patterns.

In summary, the urban construction supply chain is unique and understudied. The construction sector suffers from a low productivity and so does its supply chain. The risk of downward cycles is a barrier to investment in productivity from construction related companies. Experiences from the ongoing CIVITAS Horizon 2020 project “SUCCESS”, aiming at identifying the costs and benefits associated with the introduction of Construction Consolidation Centres and other optimization strategies, are used to identify potential ways to make urban construction logistics more sustainable.

Among the good practices, the Construction Consolidation Centre (CCC) is a particularly promising one to reduce the negative externalities of the UFT caused by construction works. The concept is very similar to the better known Urban Consolidation Centre (UCC), but it is focused on customers from the construction sector. Instead of delivering directly to the one or more construction sites, suppliers can deliver to a CCC situated in relatively close proximity to the site(s). Deliveries are then consolidated and carried out to the construction site(s) on a just in time basis. The CCC can also provide a range of other value-added logistics and retail services, such as temporary material storage, recycling and off-site construction. ICTs could also bring interesting improvement to the sector in terms of productivity and profitability. RFID (Radio Frequency identification) technology offers significant advantages to keep track of materials, tools and equipment for example. The tag fixed on the item (pallets, tools, pipes, and precast materials...) can be read without contact. The growing range of practical applications in the construction industry create opportunities for improving the supply chain and for costs savings.

Off-peak deliveries are an interesting practice to further explore in the construction sector. Extending delivery times to evening and night times or during the weekend adopting practices that minimise the noise generated during the delivery to avoid disturbing local residents can benefit to several stakeholders. Reduced environmental nuisances and more efficient deliveries are the main benefits for transport operators, developers, local authorities and residents. In its end, the SUCCESS project will deliver methods and tools to self-assess one’s construction supply chain and to prioritise the areas for improvement, thus helping the actors that want to innovate.

Acknowledgements

The authors would like to acknowledge the European Union's H2020 research and innovation programme for funding the SUCCESS project under grant agreement no. 633338 (www.success-urbanlogistics.eu) as well as the construction companies for collecting and providing data used in this study.

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