The Dualism of Urban Freight Distribution: City vs. Suburban Logistics

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Abstract

This paper identifies the implications of sub-urbanization for urban freight distribution and explores the extent to which suburban logistics deserves attention as a distinct dimension of urban freight transport research. The main trends increasing the relevance of suburban logistics are identified, making it the norm rather than the exception. It is argued that a dualism in urban freight distribution between the central areas and suburbia is emerging. This dualism involves very different functional and operational characteristics. Recent developments including regulations enforcing city logistics strategies such as tolls or off-peak hour deliveries, urban land-use designs based on smart growth principles, and the emergence of e-commerce are likely to incite a growth of this dualism. The different urban distribution channels, operations and modes depending if city or suburban logistics are involved remains to be further investigated.

Keywords: City Logistics, Urban Freight, Urban logistics, Land Use, Suburbanization, Freight Distribution, goods transport

Introduction

Cities are places of production, consumption and distribution and rely on the distribution of goods. For example, urban freight ensures the supply of groceries and retail goods in stores and enables a fast-growing home delivery market as well as express deliveries to businesses. Moreover, for production facilities it forms a vital link with suppliers and customers along global supply chains. In cities hosting seaports, airports and rail terminals serving as hubs in international and national transport networks, urban freight is essential for global trade and distribution networks (O'Connor, 2010). Urban freight, however, is challenged by the urban environment characterized by scarcity of access, such as congested roads, space constraints and limitations of infrastructure (Hesse and Rodrigue, 2004), which restricts the efficiency and reliability of freight operations. At the same time, urban freight is increasingly perceived as a conflicting activity with passenger transport and the quality of life of urban residents. Truck traffic generates significant impacts including congestion, noise, and traffic incidents. Furthermore, trucks account for up to 50% of the emission of air pollutants (depending on the pollutant considered) by transport activities in a city, although they represent only 20% to 30% of urban road traffic (Dablanc, 2007).

As the world continues to urbanize, the conflicts between urban freight efficiency and urban sustainability are getting more significant. This is further evidenced by long term demographic trends. From 1990 to 2015, the urban population increased from 2.3 billion people (43% of world's population) to 4 billion, accounting for 54% of the world's population, and as urbanization and overall growth of the world's population is projected to continue, this figure is expected to rise to 66% by the middle of this century (UN Habitat, 2016). Furthermore, there are behavioral shifts in consumption patterns with e-commerce growing significantly and accounted in 2015 for 8.4% of all retail sales in Europe and 12.7% in the USA (CRR, 2016). This trend results in a growing number of urban freight flows in the form of home deliveries of parcels.

In response to growing urban freight volumes, cities around the world have engaged in extensive experimentations to manage the challenges of city logistics. They include, for instance, the usage of alternative vehicles and modes, off-peak deliveries and the setting of distribution facilities better placed to support urban deliveries (MDS Transmodal, 2012). A substantial body of research has emerged to address the dilemma of environmental impacts and efficiency of urban freight transport (NCFRP, 2013). Yet, most of the research and policies focuses on one particular dimension of urban freight movements; last-mile deliveries to retail stores in central business districts or other high-density areas that are the nexus of urban commercial activities. Freight operations in sub-urban areas, on the other hand, are widely underrepresented in urban freight research and planning initiatives. This gap is not surprising since it is the high-density central areas, particularly in the central business districts, where the conflicts between efficient logistics and impacts of freight traffic are the most severe and evident. However, these freight flows represent a declining share of all freight flows in urban areas, as current urbanization patterns across the world are characterized by urban sprawl and lower density-based suburbanization (UN Habitat, 2016). Suburbia, characterised by higher income households in single detached houses with the private automobile use as a dominant mode of commute (Moos and Mendez, 2015), rely on low-density suburbs or edge-cities , offering good accessibility and limited externalities (such as noise and air pollution). Suburbia remains important as an urban development paradigm and is well documented as a prevailing element of the urban spatial structure (e.g. Mieszkowski and Mills, 1993).

What is less considered are the new forms of urban freight distribution that suburbia has created. Urban freight research and policy actions therefore pay little consideration to a substantial share of urban freight activity and only address a small part of the urban freight challenges. Given the significant trend of sub-urbanization urban freight distribution may require a new focus. The goal of this paper is to develop the theoretical foundations of suburban logistics and to explore whether it deserves attention as a distinct dimension of urban freight transport research. To investigate these issues, a conceptual framework integrating urban freight and urban spatial structure will be developed. Both 'freight' and 'urban' are taken in its broadest sense, including all types of freight flows (along the whole supply chain) in the whole metropolitan area (low density suburban and high-density city areas).

First, the main forms of urban freight flows and urban spatial structure are summarized in order to define the context for city and suburban logistics. Then, a framework outlining the distinctive features and fundamental differences between city and suburban logistics is developed. Third, trends highlighting the relevance and importance of suburban logistics are reviewed. The paper concludes with a discussion of the practical implications of the framework and highlights new directions for research.

Placing City and Suburban Logistics in their Context

Urban freight is a multifaceted and complex activity, particularly since it involves diverse freight flows generated and attracted by a variety of land uses. Thus, there are two key factors affecting city and suburban logistics: First, the various forms of urban freight flows serving different urban supply chains and second, the urban spatial setting in which they take place. By combining these factors, the fundamental differences between city and suburban logistics can be derived.

Main forms of urban freight flows

Cities are places of consumption, production, and distribution of material goods. Urban freight distribution includes all activities ensuring that the material demands of these activities are satisfied. As a city hosts a large number of different economic sectors, it is provisioned by a multitude of different supply chains, making urban logistics very complex and diverse. However, each economic activity taking place in an urban environment can be associated with a specific freight generation profile, which is relatively consistent from one city to another (Dablanc, 2011), even though cities throughout the world differ in terms of size, geographical conditions, economy, cultural and political values. The following categories of urban logistics with common transport characteristics can be identified.

- *Delivery to retail stores.* Urban areas host a wide range of retail facilities, which are responsible for the bulk of urban delivery activity. From a logistics perspective, two different types of retailers with different goods supply systems can be distinguished. The first one is *chain retailing*, which is served by centralized supply systems. The large retail chain stores are making use of consolidated deliveries in larger vehicles on a scheduled basis, which helps to limit the number of deliveries required. The second group involves small and medium-sized *independent specialist stores*. Their logistics differ significantly from the major retail chains in the organization of deliveries, as they are not served through centralized distribution systems. Supply is usually organized directly by their diverse suppliers, often using their own-account vehicles. As a result, independent specialist stores can receive significantly more deliveries than chain stores and are therefore responsible for considerable freight vehicle activity (Cherrett et al., 2012; Dablanc, 2011).

- *Consumer shopping trips.* The products sold in retail stores are usually brought home by the consumer on their own account, using passenger cars, public transit or walking and cycling. These consumer shopping trips, including the trip to the retail outlet to purchase the product and the trip to transport it home, can be responsible for a significant share of the freight transport energy used in the supply chain from raw material sources to retail outlet, depending on the mode of transport, the quantity of goods transported and the trip distance attributable to shopping (Browne et al., 2006). Further, these trips are often chained with other purposes, underlining their complexity (Ye et al., 2007).

- *Courier, express and parcel services* (CEP) are one of the fastest-growing urban transport businesses. Courier and express services deal with the fast transport of documents and lighter parcels with additional value-added services, while parcel services focus on heavier parcels up to 30kg (MDS Transmodal, 2012). CEP operators maintain a global network of cross dock-terminals where shipments are consolidated for delivery tours in urban areas using large vans or small to medium-sized trucks.

- One segment of the parcel business is *home deliveries*. While conventional retail channels are composed of two trips, i.e. a delivery from a distribution center to a retail outlet and a consumer shopping trip from a retail outlet to a residential home, home deliveries include a single trip from a DC to residential areas. Online shopping has grown significantly and represented in 2015 8.4% of all retail sales in Europe and 12.7% in the USA (CRR, 2016). Home deliveries are challenging operations characterized by high delivery failures, empty trip rates and a lack of critical mass in areas with limited demand, resulting in high distribution cost and emissions (Gevaers et al., 2011).

- *Food deliveries* are a significant generator of urban freight traffic. The food service industry prepares and delivers food and beverages for hotels, bars and restaurants, canteens and catering. The final customers often require specific services presenting different logistics and organizational constraints for these distribution channels, which are often referred as cold chain logistics (Morganti and Gonzalez-Feliu, 2015). The sector is generally characterized by unpredictability, and hence orders are generally very small and deliveries are often required on a Just-In-Time basis, which leads to frequent deliveries (MDS Transmodal, 2012). An emerging market which combines parcel and food deliveries are the home deliveries of fresh food.

- *Industrial and terminal haulage*. Cities are not only places of consumption but also places of production and distribution. Production facilities are often elements of global supply chains, sourcing parts from suppliers and distributing intermediate and finished goods. These facilities are commonly found close to ports, airports and rail terminals, which are transit points to regional or global transport networks.

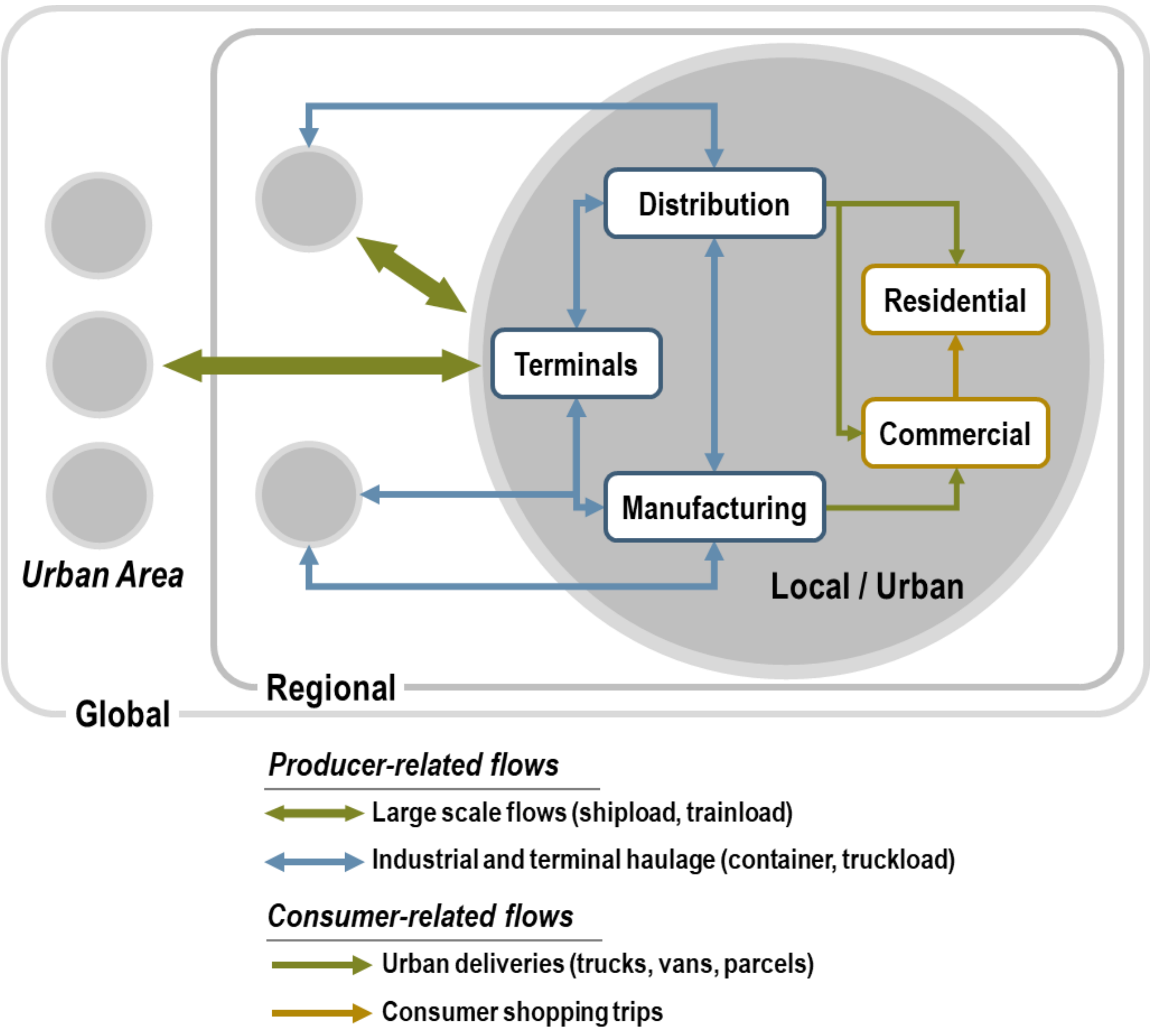

Figure 1: Types of urban freight flows and freight clusters

The distribution activities of these urban freight flows take many different forms, which can be clustered in two main functional classes of urban freight distribution (Figure 1); producer-related distribution and consumer related distribution (Rodrigue, 2013). *Producer-related distribution* includes two types of flows. The first are large-scale flows, such as interregional and global freight flows in large-scale transport modes such as vessels and trains. The second flow is industrial and terminal haulage, which usually come in unit loads such as containers and trailers, originating from or destined to terminals, production or distribution facilities within the urban area. *Consumer-related distribution* includes intra-urban freight flows, usually as part loads and parcels originating from distribution facilities and destined to commercial facilities or residential households, as well as private shopping trips from retail outlets to residential areas. These forms of urban logistics are usually clustered in certain areas, resulting in five major types of specialized freight generators (Rodrigue et al., 2013):

- *Terminals*, such as ports, airports and rail terminals, are transit points of freight flows to local regional or global transport networks (gateways). Terminals handle a wide variety of freight, i.e. bulk, containers, full truck loads (TLs) and less than truckload (LTLs). The hinterland of terminals can involve destinations (distribution centers and manufacturing sites) within the city area itself or flows having to transit through urban areas on their way to other destinations. The impact of a transport terminal on the urban area is obviously related to the intensity of the terminal activity, the supply chains it services and the extent of its hinterland.

- *Manufacturing areas* include production facilities often consisting of global supply chains producing intermediate goods and finished goods. They are mainly generators of unit loads, e.g. containers or truckloads involving all forms of road traffic.

- *Logistics zones* include distribution facilities, such as warehouses and distribution centers, where distribution activities are carried out, which includes consolidation, deconsolidation, cross-docking and storage. These facilities generate both unit loads (containers and truck loads) originating from manufacturing districts or terminals.

- *Commercial districts* are zones hosting retail facilities which are the destination of the bulk of urban deliveries through LTLs. Commercial zones also include the clustering of office towers and large institutions (seats of government, universities, museums, etc.) which generate a high demand of parcel deliveries.

- *Residential areas* are the place of consumption; hence they are the destination of the bulk of private shopping trips by car and transit as well as home deliveries from e-commerce activities.

Urban freight flows, like most freight flows, are imbalanced in their reciprocity. This is particularly the case for consumer-related flows that are usually unidirectional and related with empty backhauls. For instance, retail deliveries (most commonly from distribution centers) are one-way freight flows with the delivery vehicle returning empty or with small loads of returned goods or recyclables (e.g. boxes). Commercial to residential freight flows are almost exclusively involving consumers carrying their purchases from stores to their place of residence. Because the urban freight flows differ in terms of flow sizes and balance, the flows differ significantly in terms of vehicle operations and externalities that they impose on cities, where space constraints and emission impacts are most severe. The freight flows with high space consumption are shopping trips by car (parking space) and large-scale flows (land use of terminals). Large-scale flows are also very emission-intensive due to high levels of air pollutant emissions of vessels and rail and air noise. Therefore, depending on the setting in which these flows take place, their externalities will vary.

The spatial pattern of urban freight flows

The urban spatial structure describes the distribution of population and employment density within an urban area, which can be categorized by its level of centralization. Scholars generally distinguish between monocentric and polycentric structures. The monocentric approach (Alonso, 1964; Mills, 1967; Muth, 1969) conceptualizes the city as a circular residential area surrounding one high-density central business district (CBD) where all the employment is concentrated. The polycentric approach assumes the existence of more than one center, i.e. a number of employment and population centers of higher density, clustered some distance away around a CBD (Anas et al., 1998). Until the 1970s, the monocentric city model was the dominant paradigm for analyzing the internal structure of cities, but against the background of rapid and complex urban change resulting in city structures with multiple employment centers, the model became increasingly deficient for describing modern cities. One empirical consistency which can be observed between cities worldwide is that density declines with distance from their established centers (Anas et al., 1998). Hence, the urban spatial structure is usually divided into high-density areas and low-density areas with the transition between both commonly evident in the urban landscape.

Figure 2 underlines the expected effect of density on unit delivery costs and the respective realms of city and suburban logistics. In low density areas delivery costs per unit are higher due to the longer delivery distances. The same number of deliveries requires longer distances compared to the same deliveries taking place in more central areas. Mid-range density suburban areas represent a close to ideal environment for deliveries since delivery costs are lower as shorter delivery distances are experienced while very few constraints, particularly parking, are impacting. As density increases constraints are becoming more acute, particularly parking for deliveries which is commonly the most prevalent city logistics problem. Delivery costs thus increase rapidly in high density areas. For retailing, higher density is related to higher sales per floor space (which is highly desirable), but also less space available for storage. This high-sales to inventory ratio requires more frequent deliveries where there is usually limited parking and competition for the use of road and curb space. This requires the usage of smaller delivery vehicles (either by choice or imposed by regulation), which results in more frequent and higher delivery costs. At the highest density, delivery vehicle size may be limited, further increasing trip frequency and cost. This is the main reason why freight distribution in higher density areas commonly requires mitigations strategies and the use of alternative modes.

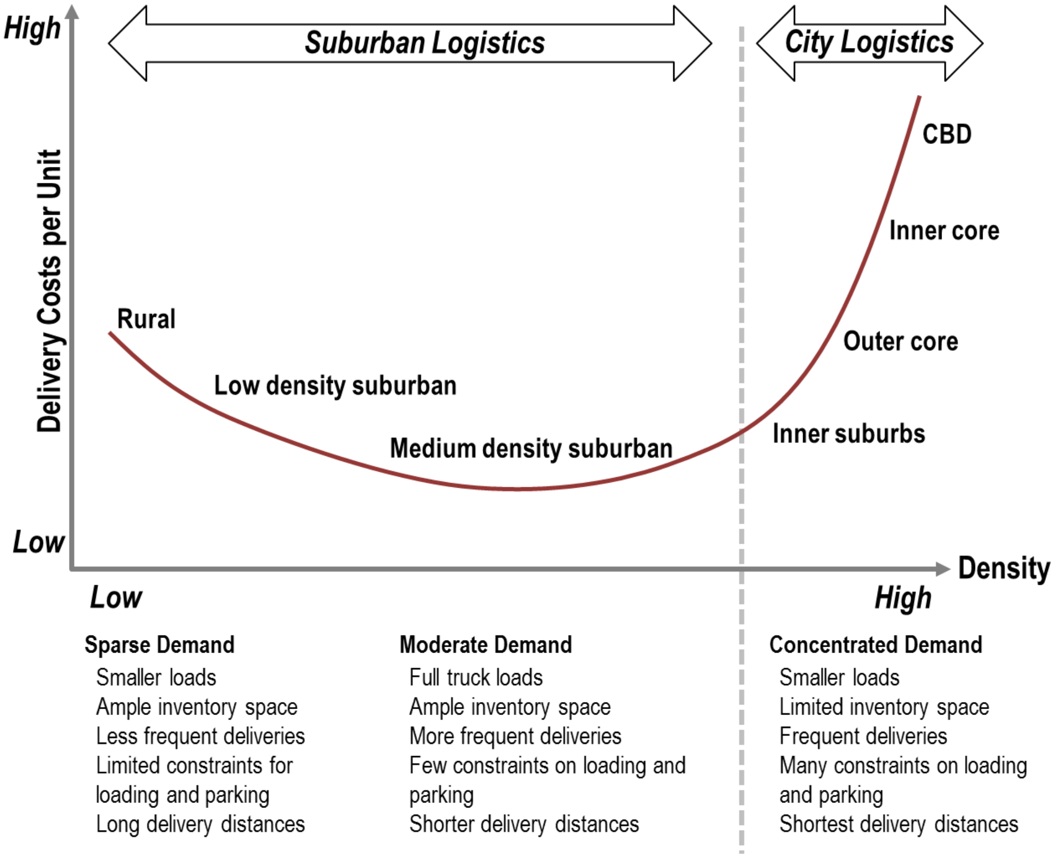

Figure 2: Relationship between Urban Density and Commercial Freight Deliveries[1]

Population density is also a crucial determinant for the environmental impact of transport operations, i.e. externalities increase with the number of people being exposed to air pollutants (Bickel and Friedrich, 2004). Hence, the externalities of comparable transport operations are significantly higher in high-density areas than in low-density areas. For example, it was estimated that in average the external costs of particle emissions in urban

[1] Source: Adapted from METROFREIGHT (2013), METRANS Transportation Center, University of Southern California and California State University Long Beach.

areas (> 1500 inhabitants/km^2) are approximately 4 times higher than in suburban areas (>300 inhabitants/km^2) and 10 times higher than in ex-urban areas (<300 inhabitants/km2) (RICARDO AEA, 2014).

These characteristics of the urban spatial structure have implications for urban freight distribution as their preconditions differ between central, suburban and ex-urban areas. *Central areas* (often referred to as CBD or 'City') are the most accessible part of the urban area. There is a high competition for a limited amount of urban space, and consequently land values are highest. Central areas are usually characterized by a high level of spatial accumulation of commercial, administrative, and cultural activities, and are therefore the destinations of the bulk of urban deliveries. Traffic density is high and congestion widespread, due to narrow streets and designated pedestrian zones or streets, which are dedicated to public transport only. Central areas are also very sensitive to traffic noise, accident risks and air pollution due to the population density and the increasing demands on an attractive urban environment. High density areas impose a limit to the freight intensity of ifs activities because of high land cost and congestion.

Compared to central areas, *suburban areas* have lower levels of accumulation of urban activities, offering higher availability of land with lower rent values. As suburban areas offer accessibility to markets (the urban core as well as neighboring suburban areas), they are highly conductive to logistics activities by permitting higher levels of freight intensity. There are generally more residential and less commercial activities in suburban areas, which are commonly multi-centric with clusters of production and distribution activities as well as large terminal facilities (ports, airports, rail). Suburbia handles the majority of the interface between the urban area and national as well as global freight networks, but also large flows of urban deliveries originate here. Due to a lower density, suburban areas are less sensitive to traffic externalities. Distribution is highly reliant on road transport, as there are limited opportunities for alternative forms of distribution. Parking difficulties are rarer and streets wider so that heavy trucks are able to circulate on most of the major roads (Rodrigue et al., 2013).

The areas beyond the suburbs of a city are commonly defined as *ex-urban areas*. In these low-density areas, the predominant land use is residential. Freight demand and sensitivity to traffic externalities is low.

The dualism of urban freight: City vs. suburban logistics

Based on a review of the main forms or urban freight flows and their spatial characteristics, a framework that conceptualizes city logistics and suburban logistics as two distinct forms of urban freight involving two very different functional and operational characteristics is proposed. Urban freight can be considered as a dualism, which is driven by urban density. To clarify matters, it is argued that urban freight is composed of city logistics and suburban logistics (Figure 3):

City logistics involves the consumer-related freight flows in high-density urban areas, including both commercial distribution as well as private consumer shopping-trips to and from retail stores in theses high-density central areas. It focuses on the well-defined functional range of urban distribution activities that are usually taking place in central areas of cities, namely the CBD. It captures the “low hanging fruits” of urban freight distribution, since in these high-density areas, where parking along the streets is limited and distribution vehicles often double-park, the challenges of urban freight distribution, such as congestion and environmental externalities, while at the same time opportunities for using load-consolidation and the use of alternative modes to road transport are the most prevalent.

Suburban logistics involves urban freight distribution taking place in low and medium-density urban areas. It includes the whole range of urban freight flows, i.e. both consumer-related and producer related distribution. There are generally more residential and less commercial activities in suburban areas, which are commonly multi-centric with clusters of production, distribution activities, terminal facilities (ports, airports, rail) as well as commercial activities (office space and shopping malls). Constraints from congestion and especially parking are usually less prevalent than in high-density central areas. Consumer-related distribution is highly reliant on road transport, as there are limited opportunities for alternative forms of distribution.

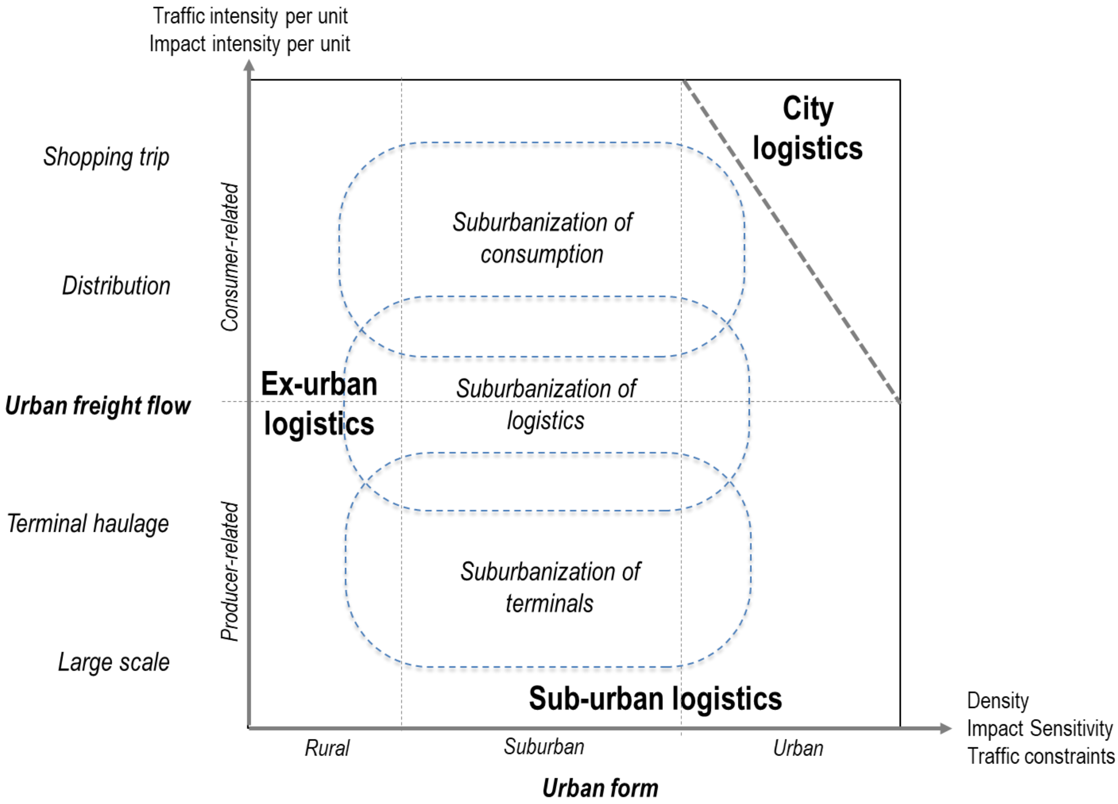

Figure 3: A conceptual framework for urban freight and urban form integration

Trends affecting the significance of suburban logistics

(Sub)Urbanization as a Consumption Paradigm

One major trend concerns the impacts of suburbanization on consumption patterns. For a long time, urban development patterns involved a strict distinction between city and suburbs where the forces of suburbanization and sprawl where at play. However, the dichotomy of city and suburbs has been replaced by highly dispersed and differentiated polycentric urban regions with many sub-centers rather than a single dominant center (Anas et al., 1998). These have usually developed in an unplanned manner with the functionality of logistics and accessibility as one dominant driving force. The new patterns of consumption in suburbia are well understood and have led in North America to common activities such as strip and shopping malls, which have emerged at accessible locations in suburban areas. This model was replicated to some extent in other parts of the world. For instance, during the last decade, out-of-town shopping centers and large-format stores continued to be developed throughout Europe, while traditional small shops and high street businesses have declined, attracting shoppers away from downtown areas and city centers (MDS Transmodal, 2012). Thus, suburban consumption patterns are increasingly found across the world. Suburban centers with commercial and office activities have become new nexuses of freight distribution, particularly if large-scale commercial activities such shopping malls are concerned. Contemporary cities therefore differ from mono-centric cities with functionally integrated suburban and central areas with extensive exchange between them. As several commercial districts and new retailing sub-centers emerged, cities are increasingly characterized by decentralization and sprawl. They are no longer dominated by a core city but have dispersed and differentiated interactions, both inwards and outwards. These polycentric regions are much more complex and diverse than the old core city and its related suburbs with mainly inwards relationships and interactions (Hesse, 2008).

Furthermore, there is a growth of e-commerce related deliveries in a suburban setting. This trend is related to new forms of demands and new forms of urban distribution dominantly associated with the home deliveries of parcels. While the concerned volumes were relatively small, the diffusion of information technologies has impacted the urban distribution structure of retail goods. This has been accompanied by a growth of parcel deliveries and new strategies to complement home deliveries. Although e-commerce is creating unique challenges for logistics in central areas, the socioeconomic (higher average incomes and larger households) and spatial composition (more unique addresses) of the suburbs are particularly prone to higher levels of reliance on this form of distributional consumption; consumption contingent to the delivery to the consumer.

Urban and suburban consumption patterns tend to be different in part because how people interact with and reach their place of consumption (Leichenko and Solecki, 2005). They differ first because of the physical characteristics of the concerned dwellings, with suburban dwellings usually of larger sizes, meaning that each housing unit is associated with a higher level of material accumulation. The composition of households differs, with larger households and younger consumers in the suburbs, which is linked with higher per capita consumption. The frequency of purchases also differs as urban households have a higher purchase frequency, particularly for perishable items, due to less storage space and differences in lifestyles. Suburban consumption patterns are thus distinctly different from those in central areas and it remains unclear if these differences are going to be expanded further with demographic changes. The ongoing development of the suburban landscape in developing economies raises additional questions concerning the emergence of specific suburban consumption pattern and their associated logistics (Wrigley and Lowe, 2002).

Suburbanization of logistics activities

A second significant trend concerns the transformation of locational characteristics of logistics activities in metropolitan areas over the last decades. Historically, many manufacturing and distribution activities were located in areas close to city centers and rail stations. Today, the growth in freight volumes due to higher consumption levels and global supply chains has required the setting of a new space to handle its logistics. New distribution centers and warehouses, which were originally located near central areas, were moved to suburban sites with good access to highway networks and airports (Dablanc and Ross, 2012). Such locations had the advantage of offering larger lots and cheaper real estate and unrestricted transport access (Hesse and Rodrigue, 2004). Dablanc and Ross (2012) define this spatial de-concentration of logistics facilities and distribution centers in metropolitan areas as *logistics sprawl*.

This transformation of logistics land use can be observed in metropolitan areas around the world. In the Paris region, for example, cross-dock terminals for parcel operations were moved an average of about 10 km away from the center of Paris between 1975 and 2008 (Dablanc and Rakotonarivo, 2010). In the Tokyo Region, the average distance of logistics facilities from the center has increased by approximately 7 km between 1980 and 2003 (Sakai et al., 2015). For Los Angeles, the average distance increased by approximately 10 km between 1998 and 2009 (Dablanc et al., 2014). This suburbanization of locations is part of an emerging landscape where large distribution clusters are located at the periphery of metropolitan areas and often acting as the distribution interface between global, regional and urban logistics (Cidell, 2010). As logistics sprawl increases the distances traveled by trucks and vans for deliveries in urban areas where jobs and households remain concentrated, it is argued that logistics sprawl contributes significantly to the traffic externalities in large metropolitan areas by generating congestion, CO_2 emissions and local atmospheric pollution (Dablanc and Ross, 2012).

The complexities of terminal-centric urban regions

An additional trend impacting suburban logistics is the evolution of global supply chains resulting in a concentration of logistics activities in fewer ports and gateways, which involve complex interactions within the urban area between intermodal terminals and clusters of freight distribution. The world's 25 largest gateways accounted for 50% of the containerized and air freight activity in 2010, with the 50 largest gateways accounting for 65%. O'Connor (2010) argues that the urban planning policies in the city regions hosting these gateways are critical to global distribution networks, as logistics activities have to compete for land use and infrastructure capacity in what are some of the most crowded and congested urban regions. While distribution and warehousing facilities have been decentralized in recent decades to suburban locations, many of the ports and rail terminals serving as gateways tend to be located near urban centers. These were originally established in the 19th century at the edge of urban areas at that time, but are now surrounded by urban development (Rodrigue et al., 2013). This urban spatial structure generates large freight flows that may pass through central areas on their way to suburban production and logistics facilities as well as to regional and global markets, which has negative implications for both the city region's sustainability and the efficiency of the global distribution networks. Trucks accessing ports and rail terminals in urban areas contribute to congestion, local air pollution, noise and safety risks. Furthermore, vessel, train and air plane operations impose significant externalities on the cities, as their exhaust pollutants and noise have a direct effect on the human population and built environment of many urbanized ports and terminals (Berechman and Tseng, 2012). Behrends (2012) shows that in case of unfavorable geographical conditions of terminal and shipper and receiver in the urban setting, the climate impact and air pollution benefits of the large-scale modes of rail and sea are achieved on the costs of higher traffic impacts from drayage operations in urban areas. While reducing the total externalities, a modal shift from road to rail can lead to higher externalities in the origin and destination cities.

The urban context in which the freight hubs are embedded is a critical factor for global and regional distribution networks. Major urban freight hubs around the world face spatial constraints due to their need to intensify and expand within already constrained and crowded land-use arrangements (Hesse, 2008). Additional friction arises from an increasing geographical imbalance between economic benefits and environmental impacts that global distribution networks generate. As a consequence of globalization and concentration the hubs have lost much of their direct relationship with local stakeholders. They increasingly serve distant and dispersed carriers, shippers and final customers and as a result a decreasing share of the hubs' economic benefits is materialized locally. For example, only 13% of the positive economic impacts of the Port of Hamburg remain in Hamburg and its neighboring states, most of it is felt in the rest of Germany and central Europe (Merk and Hesse, 2012). At the same time, it is the local stakeholders of these hubs and gateways that suffer from their extensive land use and traffic externalities. As a consequence, the hours of airport or rail terminal operations can be limited due to public planning restrictions and planning for new or expanded terminal developments, which are viewed positively at the macroeconomic level, are facing negative responses at the local authority level (Woodburn, 2008). Furthermore, freight traffic accessing hubs and gateways competes with passenger traffic for infrastructure capacity and hence is affected by urban congestion which impairs the quality and efficiency of distribution activities. It is therefore important to consider the impacts of increased freight activity not only on the suburbanizing fringe, but on existing central locations, in order to provide the required capacity for operating the freight system (Cidell, 2010).

Factors of divergence between city logistics and suburban logistics

A possible practical implication of the emerging dualism may be a compartmentalization of distribution between central and suburban areas. Traditionally, carriers operate in more or less similar ways and do not develop adapted logistics solutions for specific urban preconditions (Dablanc, 2007). Recently, however, specific logistics distribution strategies emerged to cope with the restrictions of high-density urban areas. Examples for these adapted city logistics distribution concepts include off-hour deliveries (e.g. in New York City; (Holguín-Veras et al., 2014)), last mile deliveries with small electric vehicles or cargo bikes from urban consolidation centers (e.g. in the Netherlands (van Rooijen and Quak, 2010), and Copenhagen (Gammelgaard, 2015)) or from inner-city mobile depots (e.g. in Brussels (Verlinde et al., 2014)). Hence, an implication of the emerging dualism may be that carriers develop dual distribution strategies; a city logistics distribution channel with adapted vehicles and operations, and a suburban distribution channel with standard operation procedures. The question remains which factors are at play inciting the growth of this dualism.

A first factor of divergence between city logistics and suburban logistics can be increasingly constraining policy measures in sensitive high-density urban areas. In order to solve local environmental problems and conflicts with residents, cities frequently use weight/size restrictions, parking regulations and low-emission zones (MDS Transmodal, 2012).

A second factor of divergence can be the current urban planning practices. A dominant perspective in urban planning is that higher densities are preferable as they enable to more effectively service populations with public transit or other alternative forms of transportation. However, these decisions regarding the newly derived land-use designs and patterns associated with smart growth are often disconnected from decisions regarding investments on freight. Smart growth strategies have multiple environmental and social benefits but they also raise the demand for goods movement within the urban area (Wygonik et al., 2015). Furthermore, trucks may experience lower travel speeds and detours due to the compact land use, dense road network, road-use restrictions resulting from walkable neighborhood designs, and interference with the increased volumes of pedestrians and bicycles and mixed traffic. Moreover, goods movement patterns will be affected as well in terms of shipment sizes, types of trucks used, pickup and delivery scheduling, or commercial vehicle trip chaining behavior. There is a strong risk that smart growth strategies could lead to unintended consequences, such as increased congestion, higher logistic costs, parking, and safety issues in the short term. In the long run, the freight distribution industry could respond by servicing smart growth neighborhoods in a less efficient and reliable manner, resulting in higher costs for some goods (e.g. grocery goods). This could reshape freight distributions and logistic patterns at the local, regional and even global scales, which may not always be in an efficient way.

Finally, another factor contributing to divergence is related to the emergence of e-commerce. Since e-commerce is the fastest growing segment of city logistics, the scaling up of home deliveries taking place in a variety of density and socioeconomic settings could led to a divergence as different strategies in high-density and low-density areas are observed. High density areas create benefits of consolidation due to higher loads and concentrated demand, while low density areas which offer higher accessibility and less parking constraints are prone to the benefits of lower delivery cost. The introduction of autonomous delivery vehicles such as drones and delivery robots may be more suitable in a suburban setting due to their smaller capacity. These differences may further induce dual distribution strategies as e-commerce provides additional impetus to the divergence between urban and suburban logistics. This is particularly noticeable in the locational behavior of the logistics facilities supporting e-commerce (see Table 1).

Table 1 : Logistics Facilities Supporting E-commerce (adapted from LaSalle, 2013)

Facility Type	Facility Attributes	Locational Attributes
E-Fulfillment Center	Large-sized facility (half a million to one million square foot). Cross-docking configuration common. High racks storage. Push towards automation.	Low land costs. Proximity to highways. Access to a major parcel hub.
Parcel Hub / Sortation Center	Large-sized facility (half a million square foot). Cross-docking configuration for handling trucks. Automated and semi-automated sortation.	Low land costs. Accessibility to regional distribution.
Parcel Delivery Center / Urban Logistics Depot	Medium-sized facility. Cross-docking configuration for loading vans.	Periphery of metropolitan areas.
Freight Station / Pickup Location	Small or micro-sized facility. Store-like facility (pickup location). Locker banks (freight station).	High density neighborhood locations.

Conclusion

In this paper, a framework integrating urban freight and urban spatial structure that conceptualizes city logistics and suburban logistics as two distinct forms of urban freight distribution involving two very different functional and operational characteristics was proposed. It was argued that urban freight distribution can be considered as a dualism. The current trends of suburbanization of consumption patterns; the suburbanization of logistics activities (logistics sprawl); and the concentration of logistics activities in fewer gateways increase the significance and relevance of suburban logistics compared to city logistics, making it the norm rather than the exception.

From a theoretical perspective, the framework contributes to the current knowledge on the interaction between urban freight and urban spatial structure. There are a variety of definitions of the topic of urban freight developed by scholars from different disciplines (see Lindholm (2012) for a review of the most commonly used definitions of urban freight). Although they slightly differ in scope and context how they are used, they commonly define urban freight as all goods movements to, from and through urban areas on a rather general level. Our framework presented a more detailed definition of urban freight, by including the relevance of urban density and specifying different forms of freight flows. Such a differentiated perspective on urban freight is essential for further developing the discipline. In line with this, the framework underlines the narrow focus of both urban freight research and policy, which mainly address last-mile deliveries to high-density areas, and hence only covers a small part of the freight flows in urban areas. This context actually accounts for a declining share of urban economic activities in most parts of the world. It is therefore argued that suburban logistics deserves attention as a distinct dimension of urban freight research.

Several questions arising from the emerging dualism of urban freight distribution remain, which present further research directions. To begin with, the density thresholds for the dualism should be investigated. The framework suggests that medium-density suburban areas represent a close to ideal environment for deliveries, while delivery costs increase rapidly in high-density areas, inciting the development of divergent distribution strategies. There is a need for empirical research to investigate potential threshold levels for this divergence. Moreover, is the dualism only relevant in large metropolitan areas like New York (Manhattan), Paris (within the ring road), Tokyo or London (within the congestion pricing zone), or can it be observed also in medium sized urban areas? An additional issue for further research are the forms which the divergent distribution strategies may take. Will the expected dualism involve different operations, vehicles and modes depending if city or suburban logistics are involved? Will it have implications on costs and reliability or will it simply be functional?

Finally, there is a need to understand the relevance of urban regulations and planning decisions for the emerging dualism. It has been argued that density and regulations are two possible dimensions which drive the divergence between suburban and city logistics distribution strategies. In cases where regulations drive the divergence, it is suggested that future studies should investigate the level of burden that is imposed on carriers and what unintended consequences may result from it.

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