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Themes and Challenges in Making Urban Freight Distribution Sustainable

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Abstract: The purpose of this article is to explore and classify themes and challenges in making urban freight distribution sustainable. The study has a cross sectional design which started by a narrative literature review and analysis of a sample of related literature (like peer-reviewed articles and EU (European Union) documents). It ended with complementary discussion and recommendation for tackling the challenges. The results of the study illustrate eight and seven emerged categories of themes and challenges, respectively. It is concluded that there is great need for a packet of mixed strategies as well as a more holistic perspective where all actors together analyse and design future set-ups and operation of urban freight distribution. Such a holistic view is essential in order to: understand how different actors of the chain look upon sustainable urban freight distribution, avoid sub-optimal policies/governing rules, and suggest close-to-reality solutions for tackling the challenges. Freight distribution in urban areas is the main focus of this article. In addition, the study is demarcated to eco/environmental aspect of sustainability although it is impossible to completely exclude its interaction with economic and social aspects. The results offered in this paper provide a systematic structure for classifying issues related to sustainable urban freight distribution; something which will be beneficial for managers and policy-makers when they approach sustainable supply chain management challenges. This study provides a synthesized classification of themes and challenges which can guide researchers, industries, authorities, and policy-makers in future sustainability efforts.

Key words: Urban distribution, city logistics, logistics, sustainable, sustainability, environment, themes, initiatives, challenges.

1. Introduction

During the past century, the planet's urban population grew ten-fold. Now more than half of the world's population is living in urban areas. As a result of this rapid expansion, urban areas continue to grow at a faster rate than any other land-use type [1]. In Europe, approximately 80 percent of the citizens live in urban environment [2].

Due to urbanization: new infrastructures as well as buildings are built, jobs are created, diverse services are offered, and industrialization is advanced. Growth in urban areas has been a generator of economic growth as well. In Europe, 85 percent of the GDP (Gross Domestic Product) is generated in cities [3].

Developments in urban areas are not tied with just good news. Evacuation of natural resources of the Earth like deforestation, shortage of land, and unequal distribution of power between rural and urban areas are just some cons to mention. Urbanization also increases mobility of humans and freights. Although economically and socially feasible, mobility in urban areas may lead to GHG emissions, local air pollution, energy/fuel consumption, congestion, accidents, noise, and visual intrusion. It has also negative effects on residents' health when they inhale GHGs and/or are injured by accidents and noise. Urban freight is also a large contributor to CO_2 emissions. It represents more than a quarter of the total CO_2 released by urban traffic; the fastest growing source of total CO_2 emissions in the urban environment [4]. In European Union (EU), transportation still depends on oil and oil products for 96% of its energy needs [5]. According to Eurostat (2011) transport's CO_2 emissions are constantly increasing and are the fastest-growing sector in Europe. In the same continent, urban transport is responsible for about a quarter of CO_2 emissions

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from transport, and 69% of road accidents occur in cities [6].

In this regard, EU [7] has set goals to limit climate change below 2ºC by drastically reduce GHG emissions – from all sectors of the economy – by 80-90% below 1990 levels until 2050. It is also estimated that a reduction of at least 60% of GHGs by 2050 with respect to 1990 is required from the transport sector. EU [7] has also the goal to *"halve the use of 'conventionally-fuelled' cars in urban transport by 2030; phase them out in cities by 2050; and achieve essentially CO_2-free city logistics in major urban centres by 2030"*.

However, to achieve the EU's goals sounds tremendously challenging. It is clear that by current business as usual approaches, the goals cannot be reached [7]; instead new strategies with innovative solutions are required. Breaking the current approaches, ways of thinking, and patterns of behavior is fairly complex, costly, and time-consuming. Although innovation can be radical, adaptation of new solutions as well as change of behavior are just incremental [8].

Complexity of freight- than passenger transport [9-11] and, in specific, urban freight transport and distribution [12-14] make their sustainable development challenging as well. One evidence of such complexity is large number of actors who influence freight distribution in urban/city areas such as Logistics Service Providers (LSPs), carriers, shippers/receivers (like retail stores, shops, restaurants, private consignees, and industries (construction industry, hotels, etc.)), residents, authorities, and researchers. Another dimension of such complexity is large number of activities which are/should be done in urban freight distribution operations. Some examples are consolidation, transshipment, coordination, sorting, kitting, sequencing, commercialization, packaging, storage, handling, and transportation of freight as well as reverse logistical activities (recycling, repacking, refurbishing, waste handling, etc.).

In addition, freight- than passenger movements in urban areas is much more heterogeneous and dynamic. Freights are distributed through many (distribution) channels. Furthermore, the channels (including routs and paths) may change rapidly specifically in post- and home-delivery services. However, urban freight is more polluting than long distance freight transport as urban delivery vehicles are older on average, operating speeds are slower, constant acceleration and deceleration, and vehicle idling is frequent.

Due to such complexities, McKinnon et al. [15] truly claim that "*the problems experienced by those performing freight transport and logistics operations in urban areas are far less well understood".* Until relatively recently, little attention has been paid to urban freight by researchers and policy makers [16-18]. On the other hand, different initiatives that may lead to- or the challenges that may hinder sustainable urban freight distribution are lacking in the literature [19, 20]. Although the studies by McKinnon et al. [21], Patier and Browne [22], Lindholm [23], and Behrends [24] found to be contributing for this sake, this study aims to take a more holistic view on current discussed initiatives (themes) and challenges. Such a holistic view is essential in order to: understand how different actors of the chain look upon sustainable urban freight distribution, avoid sub-optimal policies/governing rules, and suggest close-to-reality solutions for tackling the challenges.

The purpose of this article is to explore and classify the pattern of themes of initiatives and challenges in making urban freight distribution sustainable.

1.1 Demarcation

This study is demarcated to logistics in city/urban areas. All initiatives related to city logistics/urban freight distributions are in the scope of the study.

While the main focus of this study is on eco/environmental aspects of sustainability, due to the integrated nature of sustainable development, the integration of environmental issues with economic and social concerns have also been considered. In addition, phrases such as environmentally- sustainable / friendly / sound / preferable / responsible, eco, and green have been used synonymously.

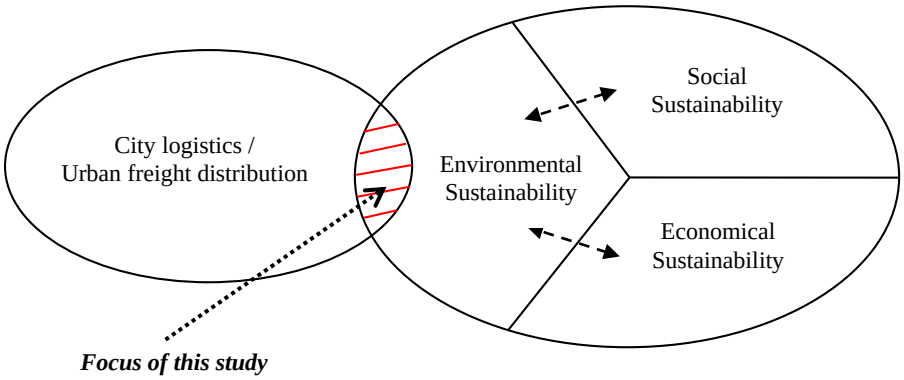

Fig. 1 Focus and demarcation of the study.

2. Frame of Reference

In 1987, a United Nations-sponsored report – published by Commission on Environment and Development (WCED) – entitled 'Our common future', also known as 'Brundtland Report', popularized the concept of 'sustainable development' and provided it with its widely known definition: *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".* Following the United Nations 2005 World Summit, sustainable development encompasses the interdependent and mutually reinforcing pillars of economic development (Profit), social development (People) and environmental protection (Planet). The three pillars or 'P's of sustainable development are also called the 'three bottom lines' or 'triple bottom lines' (TBL or 3BL). Sustainable development is also referred by similar concepts such as 'corporate sustainability' [25, 26], 'corporate responsibility' [27], or just 'sustainability' [28, 29]. Environmental pillar of sustainable development is also labeled by phrases such as 'environmentally- sustainable / friendly / sound / preferable / responsible', 'eco', and 'green' [30, 31].

Urban freight distribution deals with logistics, mainly outbound, in urban areas. Urban, in contrast to rural, is usually referred to cities and towns. The combination of urban and rural areas is called metropolitan area. Urban freight distribution activities vary from delivery and collection of goods; goods- transport, storage, consolidation, and inventory management; waste handling; office and household removals [32-34]; to cooperation among freight stakeholders [35] and freight distribution policies [36]. Urban freight distribution may also be called by similar phrases like city logistics, urban freight logistics, urban logistics, and urban goods movement [37]. City logistics is an important process for totally optimizing the logistics and transport activities by private or municipal companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy (Institute for City Logistics). Form Dablanc's perspective [38], *"urban logistics can be defined as any service provision contributing to an optimized management of the movement of goods in cities".* Alternatively, city logistics is involved in all the means over which freight distribution can take place in urban areas as well as the strategies that can improve its overall efficiency; such as mitigating congestion and environmental externalities.

3. Methodology

This study has a cross-sectional design. It entails collection of data from a variety of sources and at a single point in time [39] in order to explore pattern of themes and challenges in making urban freight distribution sustainable.

The main method of data collection was literature review. During and after literature review, data were analyzed. Analysis was done by codification (open

coding), classification, and synthesis of collected data based on principles of analytic induction. The results of the analyzed data (themes and challenges) are discussed in the next section. In the following subsections, methods of data collection and analysis are briefly explained (Table 1).

3.1 Literature Review

The study began by collecting data by reviewing several mixes of literature from several sources. However, the literature review had a more narrative than systematic nature. According to Bryman and Bell [40], the former one tends to be less focused and more wide-ranging in scope than the later one. Literature was selected from secondary sources and documents (Table 1); namely:

Peer reviewed journal and conference articles: In order to collect a purposeful sample [41] of articles, the online database at the library of Lund University in Sweden (LibHub) was selected. It includes sources such as electronic journals, E-print archives, JSTOR, IEE/IEEE standards and proceedings, and Proquest ABI database. At first, the LibHub database was searched by combination of selected keywords, namely (Urban freight*/City logistic* AND Sustain*/Environment*/ Green). The search keywords had to be in title and/or abstract and/or keywords of the articles. This led to 470 available articles. Next, the abstract of all available articles was read. In some occasions, the introduction and conclusion sections of the articles were also read or whole of the article was skimmed.

The most relevant articles to purpose and scope of the study were then selected and registered in an Excel file. In total 61 articles (13% of the total available) were selected. The criteria for selection of the articles were that the discussed data shall have a thematic character (like managerial, educational), refer to an environmentally sustainable activity/issue (like developing environmentally friendly modes of transportation), or explicitly refer to a challenge/barrier. It is worth mentioning that some articles were appeared repetitively in one or several categories. In such cases, just one of them was counted. In addition, the articles/abstracts which were written in another language than English were not selected. The selected articles were then totally read by both authors.

Books and doctoral dissertations: Some hard copy or E- books and doctoral dissertations relevant to purpose of the study were read during the data collection and analysis phases.

Documents and reports from 'Øresund EcoMobility' project: This study was one part of the 'Øresund EcoMobility' research project (http://www.oresundecomobility.org/). All relevant publications, documents, and reports available on homepage or intranet of the project were read.

Table 1 Methods and sources of data collection and analysis in this study.

		Source(s) of data
Methodology	*Literature review*	1. Peer reviewed journal and conference articles 2. Books and doctoral dissertations 3. Documents and reports from selected websites 4. Documents and reports from 'Øresund EcoMobility' project
	Analytic induction	Collected data from literature review

Documents and reports from selected websites: During the data collection phase, relevant documents and reports from two websites were also read. These websites are: 'European Commission-Mobility & Transport (http://ec.europa.eu/transport/index_en.htm)' and 'Europa-Gateway to the European Union (http://europa.eu/index_en.htm)'. These two were interesting for those financiers of the research project from European Union (European Regional Development Fund).

3.2 Analytic Induction

Analytic induction [42, 43] was the main method for analysis of data in this study. The main reason to use

this method was to allow the categories of themes and challenges emerge out of the collected data. This is very well in match with inductive reasoning of qualitative researchers. The principle was to seek universal explanation of categories of themes and challenges by pursuing the collection of data until no cases that were inconsistent with the emergent categories were found. On the other hand, collection of data was continued until theoretical saturation. This means that: successive literatures had both formed the basis for the creation of a category - after open and focused coding [44] - and confirmed its importance; there was no need to continue with data collection in relation to that category or cluster of categories.

Worth to mention that '*code memos*' [45] were used during open and focused coding where the names of the different codes, who coded which parts of the material, the date when the coding was done, definitions of the codes used, and notes about the thoughts about the codes were recorded. The generations of codes were purely '*data driven*' than '*concept driven*'. Concept-driven coding uses codes that have been developed in advance by the researcher, either by looking at some of the material or by consulting existing literature in the field, whereas data-driven coding implies that the researcher starts out without codes, and develops them through reading of the material.

3.3 Judging Research Quality

In line with Bryman and Bell's [46] suggestions for evaluating qualitative research, two criteria were considered: *Trustworthiness* and *Authenticity*. Main measures to increase trustworthiness of the results were: transferability (generating representative samples of literature) and dependability (creating a research logbook/black box which entails complete records of every single phase of the research such as: problems formulation; selection of samples; literature reviews; coding schedule and manual; memos of open and focused coding; and data analysis procedures). In addition, analyses of collected data were done by both authors in order to decrease subjectivity in coding of data. On the other hand, in order to increase authenticity of the results, several mixes of literature from several sources were selected and the results were discussed among the research project's stakeholders.

4. Results

Systematic review and analysis of the literature led to identification of the pattern of discussed themes and challenges. This section provides a classified synthesis of identified themes and challenges.

4.1 Identified Themes

Eight themes were identified. The identified themes are explained here in detail.

4.1.1 Juridical and financial regulations/restrictions/ limitations

Limitations and restriction are related to policies that aim to make freight distribution sustainable by regulating access to urban areas.

4.1.1.1 Time Restrictions – Delivery Timing – Vehicle Access Time Restrictions

These regulations – usually called *access time windows* – aim to restrict the time of collection, delivery/loading and unloading of freight in urban areas. The most common form is *night deliveries* that may reduce noise pollution, traffic congestion, vehicles fuel consumption and as a result, GHG emission of freight distribution during the daytime [48-51]. According to Álvarez and de la Calle [52], night deliveries have reduced the fuel consumption and CO_2 emissions by 15 to 20% in some European cities. Relaxation of access time windows and their harmonization among different municipalities can result in a relief of the environmental burden and a cost decrease for the retailers, too [53].

4.1.1.2 Vehicle Load Capacity Restrictions – Vehicle Access Weight/Size/Capacity Restrictions

Restrictions on vehicle access weight and size are some of the most common mobility policies and legislation. The goal is to restrict the entrance to urban areas of vehicles that surpass the specified gross weight,

length, width, and height in urban areas. Such restrictions may lead to the reduction of congestion, pollution, intimidation, safety concerns, vibrations and noise in urban areas especially where pedestrians and other road users are present [54, 55]. Another reason to introduce such restrictions is the limitations in infrastructures in urban areas such as height of bridges, width of carriageways, and dimensions of city squares.

4.1.1.3 Environmental Zones/Low Emission Zones/Clear Zones

Environmental zones – sometimes called low emission zones or clear zones – relate to geographical areas that can be entered by vehicles meeting certain emissions criteria/standards or below a certain age. The aim is to improve air quality in urban areas by encouraging the use of less polluting engine technologies [56] and more modern and cleaner vehicles [57].

4.1.1.4 Financial Regulations/Means

There are also some financial means that can impact the environmental sustainability of urban freight distribution. The most common ones, reflected in the literature, are congestion charging [58-60], which is also called congestion pricing or road pricing. The aim is to reduce the number of vehicles that enter specific urban areas – especially where road and parking space are scarce –increase the average speed of vehicles – because of reduction in traffic intensity – and internalize the external costs originated by traffic congestion [61, 62]. Toll systems [63] and taxes on vehicles are other mechanisms for reducing traffic intensity and congestion in urban areas.

4.1.2 Structural and Infrastructural

These relate to initiatives that aim to make urban freight distribution sustainable by restructuring the supply chain design or maximizing the capacity utilization of existing infrastructures.

4.1.2.1 Urban Consolidation Center (UCC)

The goal of UCC initiatives is to consolidate the freight flows from outside the city before delivery in urban areas. This will help to bundle inner-city transportation activities [64, 65]. Browne et al. [66] consider a wider goal of UCC by stating that *"UCC is best described as a logistics facility that is situated in relatively close proximity to the geographic area that it serves, be that a city center, an entire town or a specific site (e.g. shopping center), from which consolidated deliveries are carried out within that area".* UCCs are also called by similar phrases [67] like urban shared use freight terminals [68], city terminals [69], city distribution centers [70], and urban freight consolidation centers [71].

The main advantage of UCCs is reduction of traffic intensity (total number of operating vehicles) in urban areas by improving the load factor and empty running of vehicles. However, it might take more small vehicles to replace the large vehicles, which could increase the number of vehicles in the city. Such initiatives can also reduce- fuel/energy consumption per ton-km, vehicle emissions and noise generation in delivering goods as well as making the area more pedestrian-friendly. According to Goldman and Gorham [72], such initiatives have reduced number of truck trips into the city and truck operating times by 70% and 48%, respectively in some German cities.

4.1.2.2 Maximizing Capacity Utilization of Existing Infrastructures

Some literature sheds light on initiatives that aim to maximize the capacity utilization of existing roads, parking places, load/unloading areas, and pedestrian/bicycle ways. "Multi-use lanes", common use of "public and private parking lots"– mainly used for passenger vehicles – or "other reserved spaces" (taxi zones, bus lanes, motorcycle parking spaces, and parking spaces for disabled people) during certain time intervals are some of these initiatives that adapt the use of public roads and spaces to the different freight distribution operational needs emerging during the day.

"Load zone provision", "delivery zones", and "dynamic allocation of loading and unloading places" – reserved spaces to be used by delivery vehicles for loading or unloading freight in certain dense urban

areas – as well as "temporal individual load spaces" and "short time double parking" are other initiatives worth mentioning. Although these initiatives may not reduce the number of vehicles during peak hours, they can reduce traffic intensity and congestion by facilitating parking, and loading/unloading operations.

4.1.2.3 Underground Urban Goods Distribution

The aim of underground urban goods distribution initiatives is to utilize the underground links or network for distribution of goods among distribution centers around urban areas and receivers (like shops) inside the urban areas. According to Binsbergen and Bovy, the concept of underground goods transportation has potential feasibility for urban distribution of food products and consumer goods. It can also reduce noise levels, improve local air pollution, and decrease energy use for propulsion.

4.1.3 Managerial

Managerial issues are related to activities that can contribute to the sustainability of urban freight distribution such as planning, control, measurement, monitoring, modeling, assessment/evaluation, cooperation/coordination/collaboration, and partnership.

Modeling activities are reflected on in several articles. These range from multi-criteria decision-making approaches for location planning for urban distribution centers under uncertainty to peak-hour urban freight movements with limited data availability, and CO_2 emissions for different levels of congestion and time-definitive customer demands. Modeling can also be found in Gao and Sheng who take advantage of simulation methods combined with improved heuristic algorithms to solve the dynamic vehicle routing problem with time windows (DVRPTW) in real city environments.

Evaluating activities can be found in Awasthi and Chauhan who present a hybrid approach for evaluating four city logistics initiatives: vehicle sizing restrictions, congestion charging schemes, urban distribution centers and access timing restrictions. Hensher and Puckett present a choice-modeling framework for *assessing* the influence of distance-based charges on freight transporters. Route *planning* of delivery fleets and *mapping out* the pattern of goods distribution in order to reduce costs, congestion, and environmental impact are other activities of a managerial thematic character.

Cooperation, *coordination*, and *collaboration* are inseparable activities of sustainable logistics and supply chains. Urban freight distribution is not an exemption. *Partnership* between public and private sectors, inter-organizational cooperation among actors and stakeholders involved in city logistics, cooperation in distribution channels, and coordinated goods flows are just a few examples of managerial activities.

4.1.4 Environmentally Friendly Modes of Transportation

These initiatives relate to design and production of new green modes of transportation as well as taking advantage of inter- and co-modalities.

4.1.4.1 Inter- and Co-modality

Transferring freight from urban roads to rail and marine – which may have less energy intensity per ton-km – are among the discussed activities in making urban freight distribution sustainable. Co-modality, by combining different modes together, like cargo- trams and ferries combined with electric powered trucks, freight busses and metro, and passenger and cargo trams are some other initiatives. Inter- and co-modality by shifting to non-road modes of transport can reduce congestion on roads as well as costs of distribution operations.

4.1.4.2 Developing Environmentally Friendly Vehicles

Designing, developing, and producing more environmentally friendly vehicles – with less energy and emission intensity – are inseparable parts of zero emission and eco-mobility strategies. Using electric vehicles like electric lorries and vans, zero emission vehicles powered by hydrogen, and gas and electricity powered trucks can all contribute to environmentally friendly city distribution operations.

4.1.5 Technological Developments

Developing clean/green/environmental technologies are permanent strategies towards sustainable development of city logistics, logistics, and supply chains. Several articles shed light on ICT as enablers of green urban freight distribution. They are also some major enablers of world-class infrastructure. Such technologies are also keys to integrated, connected, visible, adaptive, and intelligent supply chains. ICT can be found in today and in the future of sustainable urban freight distribution to track and trace goods and resources of supply chains and take advantage of Global Positioning Systems (GPS), route optimization, variable message panels, traffic management systems, identification tags, smart cards, computer software and hardware, emission calculators, parking monitoring tools, on-line load zone reservations. According to Weber, *"Bottom-up processes of strategic niche management with new emerging technologies have the potential to trigger regime shift towards a more sustainable supply of energy and transport services."*

4.1.6 Emissions and Fuels Economy

Developing sustainable fuels with zero emissions and without antagonistic effects somewhere else, like destroying food resources or high costs, improving engine efficiency, and controlling measures towards reduction of emissions, are long-term trends that can reduce energy and emission intensities of freight distribution in urban areas. Among the related reviewed literature, Yoshizumi et al. have studied diesel emission levels of several urban driving cycles and analyzed the effects of average speed on emissions and fuel economy by diesel trucks. Another example is Gebresenbet et al. who have studied emission estimation for an urban food delivery system.

4.1.7 Distribution Services

Distribution services are complementary to sustainable physical freight distribution. Some exemplary services which can reduce transport intensity, traffic intensity as well as congestion and emissions in urban areas are: home service distribution, neighborhood drop-off points, use of packaging automates in the distribution process, DHL pack stations and BentoBox.

4.1.8 Educational

Education and change of behavior are building blocks of making and developing sustainable supply chains. Education plays an important role in informing the human resources of dimensions of sustainability as well as improving their performances.

4.2 Identified Challenges

Seven challenges were identified and classified and are explained in the following sub-sections.

4.2.1 Decoupling

Economic growth both effects and is affected by freight distribution and transport growth. Traditionally, goods transport increases with growth in the GNP. In many urbanized European regions, the pace of growth in goods transport is about twice that of the GNP. The challenge is to decouple economic growth from an increase in urban freight mobility and environmental damage/degradation. As Afroz et al. reflect, the challenge is to develop collaborative business models to *"meet the future challenges of the growth of trade, freight movement and maintaining economic, environmental and urban sustainability."* To achieve the EU targets is very challenging as the emissions should drastically reduce by 2020 and 2050 while the number of vehicles and the population are increasing.

4.2.2 Restructuring

Dynamic restructuring of patterns of urban freight distribution has made its sustainable development challenging, too. For example, the growth of e-business/e-commerce, home deliveries, and just-in-time (JIT) trends have drastically changed the B2C (business to consumers) as well as B2B (business to business) transactions by having antagonistic effects on the environment and sustainability. The scenario becomes even more challenging when freight distribution in urban areas is influenced by global supply chains/networks. As Markus discusses, both

"global change" and "global chain" may lead to "local pain". (…) "*Increasing globalization and global economic integration exert constant pressure on local places to adapt to these processes."*

Adaptation to these changes and reconfiguration of freight distribution may also lead to further challenges in urban areas where the infrastructures, spaces, and resources are limited; roads and streets are narrow and compact (especially in historic and central parts of cities).

4.2.3 Costs/Financial Viability

A major challenge in making urban freight distribution sustainable is cost. In general, in the same time period, the average costs of freight distribution in urban areas (short distance) is higher than inter-city (long distance) freight distribution. The reasons are higher fuel consumption of vehicles due to more congestion and less average speed as well as more stops and load/unload operations in urban areas.

Corporate social responsibility – including both environmentally and socially sustainable – initiatives, activities, and strategies that may threaten economical sustainability are less likely to be continued. This is a real challenge, as many of these may be very costly, at least initially. For example, although environmentally beneficial, adding urban consolidation centers/terminals/cross-docks can result in potentially high set-up and operating costs. There is also an increase in delivery costs because of the additional stage in supply chains, potential costs associated with additional companies handling goods, and increased transaction costs.

High investment costs in developing, constructing, or restructuring the infrastructure is also a challenge. For example, it is costly to build and maintain new (cargo) tramlines, underground distribution links, new fuel stations, dry ports, hubs, and intermodal terminals. It is also costly to shift the fleet to more environmentally friendly ones and develop new fossil-free fuels as well as clean/green/environmental technologies.

4.2.4 Operationalization

Several factors make sustainable urban freight distribution operationally challenging. One is the considerable lack of knowledge and understanding of the nature of city logistics and initiatives/themes. The problems caused by freight transport and distribution in urban areas are far less well understood. A comprehensive evaluation and evidence-based information of full financial, environmental, and social impacts of city logistics initiatives is lacking in the literature, too.

Another factor is the reluctance of city logistics stakeholders to accept or participate in initiatives. For example, night deliveries where the receiver must be present when the delivery is made are not always acceptable. There are also concerns about higher driver wages, higher reception/dispatch costs, and safety when it comes to night deliveries. Another common example is the construction and operations of a UCC initiative that may be ultimately doomed to fail if those who are the potential customers refuse to participate. There are some evidence-based studies attesting that businesses with frequent, differentiated, and high-volume deliveries are less willing to use UCC services where much of the urban freight is already consolidated at the intra-company level or by parcels carriers. In most of such businesses, the vehicles are already fully loaded. In addition, businesses dealing with valuable goods as well as bars, restaurants, and hotels – which demand higher frequency, punctuality, and logistics quality – are more reluctant to participate. McKinnon et al. also elaborate on difficulties that may emerge for a single UCC as it may be unable to handle the wide range of goods moving in and out of an urban area, due to such factors as different handling and storage requirements. Browne et al. add that: *"A single consolidation center for an urban area is unlikely to be attractive for many suppliers' flows due to the degree of diversion required from normal route (and may therefore negate transport savings for onward distribution)."* Obligation and compulsion can also

threaten the sustainability of UCCs by making the potential customers as well as private sector unwilling to participate and/or pay.

Inefficiency in urban freight distribution is another factor that can make the operationalization of sustainable development challenging. It is fairly challenging to improve the efficiency of urban mobility while ensuring environmental quality and economic growth as well as maintaining livable communities. Inefficiencies in urban freight transport can occur as a result of existing road layouts or traffic levels, unintended consequences of non-freight urban transport policies on freight transport operations (e.g. the introduction of bus lanes), variations in urban freight transport policy measures in different urban areas or different parts of a single urban area, and counterproductive institutional roles and procedures.

4.2.5 Uncertainties

Another challenge is related to uncertainties inherited in different aspects of urban freight distribution and sustainability. There are several strategic uncertainties regarding production capacities and logistics of new fossil-free fuels, design/location and capacity planning/viability of supply chain static resources (like distribution centers, UCCs, terminals, facilities) in urban areas, construction of new infrastructures, behavioral effects of congestion charging regimes, etc.. There are also operational uncertainties due to unexpected/unforeseen incidents like order cancellation, delivery time changes, new customer requests, traffic congestion, road construction, flea markets, natural disasters, weather changes, accidents, and mechanical failures. Other uncertainties are due to the psychological reluctance of customers to buy clean technologies, as they might not be fully convinced of their practicability and chance of survival on the market.

Finally, yet importantly, there are uncertainties, dilemmas, and misunderstandings regarding paradoxical/contradictory/antagonistic effects of freight distribution activities/initiatives in urban areas. For example, “Lean” and “just-in-time” (JIT) may increase service levels and efficiency of freight distribution while at the same time leading to small order problems and increased less-than-truckload (LTL), empty running, costs, congestion, fuel consumption, and GHG emissions. There are also dilemmas in decision making for the facility location of static resources. For example, locating distribution centers close to customers’ locations may increase traffic congestion in urban areas while locating far from them may increase costs of transportation or destroy green fields.

4.2.6 Lack of Visionary Leadership

Today, there is a lack of visionary leadership in making urban freight distribution sustainable as visions and goals are vague, short-term market perspectives are in focus, and potential long-term benefits of initiatives and legislation are misunderstood. This is a real challenge in the construction and development of infrastructures as they last for several decades; it takes many years to plan, build and equip them, and considerable investment will be needed.

In addition, there are tremendous difficulties in creating a new and innovative urban mobility culture that all stakeholders accept and follow the legislation and initiatives. To change and shift the organizational culture is also tied to behavioral challenges, as there is a very high inertia and resistance to change. Sustainable development brings significant challenges to traditional business models – which have a clear focus on financial aspects only – and the ways that different stakeholders define their missions and strategies, and organize their work and operations.

4.2.7 Corporate Governance

Another challenge is related to corporate governance of freight distribution in urban areas. For example, there are bureaucratic difficulties and administration barriers embedded in decision making where several actors at different levels, from municipality and regional to state levels, influence urban distribution. Other dimensions of the difficulty of corporate

governance of urban freight distribution are variations in urban freight transport policy measures in different urban areas or different parts of a single urban area, governmental policies and rules related to zoning, emissions, vehicle restrictions, and access conditions to roads and terminals. The scenario becomes even more complex when it comes to the development of sustainable and integrated/united continental or global governing bureaucracies and measures.

In an analysis of barriers to urban transport sustainability, Jönson and Tengström highlight the lack of political commitment and national policy framework: *"When the political will is lacking, the problems can be recognized, but are not deemed enough – in practice – for there to be a real change in the system in place."* On the other hand, Dablanc elaborates on local policies and similarly concludes that in major European cities, local public policies regarding freight are scarce and out-of-date: *"Because of the impacts of freight on the urban environment, local governments are aware that they should control goods transport activities, but most do not know how" (…) "For most cities, existing freight policies do not appear to measure up to the important changes which have taken place in the production, distribution and consumption sectors."*

Other challenges raised in the literature are: Poor policy integration and co-ordination, unsupportive legal or regulatory framework/ policy measures, wavering political commitment; potential to create monopolistic situations, thus eliminating competition and perhaps leading to legal issues; and unwillingness to collaboration among producers or between large-scale and small-scale transport companies and uncertainties regarding who takes the initiative.

5. Concluding Discussion

As it is clear from the identified themes, urban freight distribution cannot become sustainable with just one activity or theme of activities. Instead, a packet of themes of activities and mixed strategies with minimal antagonistic effects on each other is required. The identified themes may help the readers to have a more holistic view on the main activities discussed in literature. Taking a holistic view while development sustainable urban freight distribution is essential in order to understand economic, environmental, and social effects of identified themes on each other and avoid sub-optimal, irrationalized, and based on intuition discussion and decision making. Taking short-term perspective and/or considering urban freight distribution in isolation from their supply chains or other aspects of urbanization will not make them sustainable. It is also important to realize that 'one shoe does not fit all'. The packet of activities and strategies should also be adaptive as each urban area is unique. Differences among shape, size, nature, and society of urban areas have led to different types of freight distribution inside them. The urban freight distribution needs to be adjusted to the local context and user requirements as well as regulations and policies of a specific city. It should also be adaptive to new clean technologies and infrastructures.

5.1 Recommendation for Tackling the Challenges

In order to tackle the challenges, it is recommended that the complexity of such a complex socio-technical system (urban freight distribution) be harnessed, visionary leadership for transformation of this system towards sustainability be appreciated, and both top-down and bottom-up changes be considered.

5.1.1 Harness the Complexity

Urban freight distribution is a complex socio-technical system with tremendous number of interconnected actors/stakeholders and activities which influence its sustainable development. In order to harness this complexity, these actors and activities shall be identified and classified, and their effects on sustainability of urban areas/cities (environmental protection, livable human societies, and economic profitability) shall be managed. In addition, effects of current and future business and market trends on urban freight distribution must be fully investigated. For

example, the role of: globalization in distribution industries - and, vice versa, the significance of distribution in globalization, future of ICT (Information and Communication Technologies), and clean technologies deserve full investigation.

5.1.2 Visionary Leadership

Urban freight distribution calls for charismatic visionary leaders who may transform it towards sustainability and develop it sustainably. It is also necessary to shape a new culture of sustainable mobility among all the stakeholders where big and innovative ideas be heard, developed, and evolved. Education, information, and innovation are important factors for creation of such culture.

5.1.3 Top-down and Bottom-up Changes

Both top-down and bottom-up strategies and initiatives should be considered for transformation of complex city logistics towards sustainability. Governmental subsidies, funding, and liberalized policies and restriction are some examples of top-down ones. On the other hand, some bottom-up examples are: collaboration of local stakeholders and practitioners (like retailers, transport operators, shippers, and residents) by taking part in initiatives as well putting pressure on local and central government. Combination of bottom-up initiatives with top-down legislation may increase the chance of acceptance and operationalization of all pillars of sustainable development.

References

[1] Abbasi ,M. (2012), *Themes and challenges in developing sustainable supply chains – Towards a complexity theory perspective*, Licentiate thesis, Media-Tryck, Lund, Sweden.

[2] Abukhader, S.M. (2005), *Towards horizontal environmental assessment for supply chain and logistics management*, PhD Dissertation, KFS AB, Lund, Sweden.

[3] Afroz, R., Tudin, R., Hanaki, K., and Masud, M.M. (2011), "Selected socio-economic factors affecting the willingness to minimise solid waste in Dhaka city, Banglades", *Journal of Environmental Planning and Management*, Vol. 54, No. 6, pp. 711-731.

[4] Álvarez, A. and de la Calle, A. (2011), "Sustainable practices in urban freight distribution in Bilbao", *Journal of Industrial Engineering and Management*, Vol. 4, No. 3, pp. 538-553.

[5] Amico, M., Deloof, W., Hadjidimitriou, S., and Vernet, G. (2011), "CityLog - Sustainability and efficiency of city logistics: The M-BBX (Modular BentoBox System)", in *2011 IEEE Forum on Integrated and Sustainable Transportation Systems*, pp. 132-135.

[6] Anderson, S., Allen, J., and Browne, M. (2005), "Urban logistics – how can it meet policy makers' sustainability objectives?", *Journal of Transport Geography*, Vol. 13, No. 1, pp. 71-81.

[7] Angheluta, A. and Costea, C. (2011), "Sustainable go-green logistics solutions for Istanbul metropolis", *Transport Problems: an International Scientific Journal*, Vol. 6, No. 2, pp. 59-70.

[8] Aras, G. and Crowther, D. (2009) "Making sustainable development sustainable", *Management Decision*, Vol. 47, No. 6, pp. 975 – 988.

[9] Awasthi, A., Chauhan, S.S., and Goyal, S.K. (2011). "A multi-criteria decision making approach for location planning for urban distribution centers under uncertainty", *Mathematical and Computer Modelling*, Vol. 53, No. 1-2, pp. 98-109.

[10] Awasthi, A. and Chauhan, S.S. (2012), "A hybrid approach integrating Affinity Diagram, AHP and fuzzy TOPSIS for sustainable city logistics planning", *Applied Mathematical Modelling*, Vol. 36, No. 2, pp. 573-584.

[11] Behrends, S. (2011), *Urban freight transport sustainability – The interaction of urban freight and intermodal transport*, PhD Dissertation, Chalmers University, Gothenburg, Sweden.

[12] Binsbergen, A.V. and Bovy, P. (2000), "Underground Urban Goods Distribution Networks", *Innovation: The European Journal of Social Sciences*, Vol. 13, No. 1, pp. 111-128.

[13] Bhuiyan, M.F.H, Awasthi, A., Wang, C., and Zhiguo, W. (2010), "Decentralized urban freight management through market based mechanisms", in *2010 IEEE International Conference on Systems, Man and Cybernetics*.

[14] Björklund, M. (2005), *Purchasing Practices of Environmentally Preferable Transport Services – Guidance to increased shipper consideration*, PhD Dissertation, Lund University, Lund, Sweden.

[15] Browne, M., Sweet, M., Woodburn, A., and Allen, J. (2005), "Urban freight consolidation centres: final report", Transport Studies Group, University of Westminster, London, November 2.

[16] Bryman, A. and Bell, E. (2007), *Business research methods*, Oxford University Press Inc, New York.

[17] Charmaz, K. (2006), *Constructing grounded theory: a practical guide through qualitative research*, Sage Publications, Inc.

[18] Dablanc, L. (2007), "Goods transport in large European cities: Difficult to organize, difficult to modernize",

Transport Research, Part A, Vol.41, No.3, pp. 280-285.

[19] Dabland, L. (2008), "Urban Goods Movement and Air Quality Policy and Regulation Issues in European Cities", *Journal of Environmental Law*, Vol. 20, No.2, pp.1-22.

[20] Dinwoodie, J. (2006), "Rail freight and sustainable urban distribution: Potential and practice", Journal of Transport Geography, Vol. 14, No. 4, pp. 309-320.

[21] Edoardo, M., and Danielis, R. (2008), "The potential demand for a urban freight consolidation centre", *Transportation*, Vol. 35, No. 2, pp. 269-284.

[22] European Union. (2009), "*A sustainable future for transport*", *European Communities*, Publication Office of the European Union, Luxembourg.

[23] European Commission. (2011), *White paper: Roadmap to a Single European Transport Area-Towards a competetive and resource efficient transport system.*

[24] Eurostat. (2011): http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home.

[25] Figliozzi, M.A. (2011), "The impacts of congestion on time-definitive urban freight distribution networks CO_2 emission levels: Results from a case study in Portland, Oregon", *Transportation Research Part C*, Vol. 19, No. 5, pp. 766-778.

[26] Gao, J., and Sheng, Z. (2008), "Research for Dynamic vehicle routing problem with time windows in real city environment", in *2008 IEEE International Conference on Service Operations and Logistics, and Informatics*, Vol. 2, pp. 3052-3056.

[27] Gebresenbet, G., Nordmark, I., Bosona, T., and Ljungberg, D. (2011), "Potential for optimised food deliveries in and around Uppsala city, Sweden", *Journal of Transport Geography*, Vol. 19, No. 6, pp. 1456-1464.

[28] Goldman, T. and Gorham, R. (2006), "Sustainable urban transport: Four innovative directions", *Technology in Society*, Vol. 28, No. 1-2, pp. 261-273.

[29] Gonzalez-Feliu, J., and Morana, J. (2011), "Are city logistics solutions sustainable?", *Journal of Land Use, mobility and Environment*, Vol. 3, No. 2.

[30] Hensher, D.A. and Puckett, S. (2008), "Assessing the Influence of Distance-based Charges on Freight Transporters", *Transport Reviews: A Transnational Transdisciplinary Journal*, Vol. 28, No. 1, pp. 1-19.

[31] Himanen, V., Lee-Gosselin, M., and Perrels, A. (2004), "Impacts of Transport on Sustainability: Towards an Integrated Transatlantic Evidence Base", *Transport Reviews*, Vol.24, No.6, pp. 691-705.

[32] http://ec.europa.eu/transport/index_en.htm.

[33] http://europa.eu/index_en.htm.

[34] http://www.oresundecomobility.org/.

[35] Institute for City Logistics, available: http://www.citylogistics.org/.

[36] Jeffers, P.J. (2010), "Embracing sustainability: Information technology and the strategic leveraging of operations in third-party logistics*", International Journal of Operations & Production Management*, Vol. 30, No.3, pp.260-287.

[37] Jönson, G. and Tengström, E. (2005), *Urban transport development. A complex issue 34*, Berlin/Heidelberg, Springer.

[38] Kawamura, K. and Y.D. Lu. (2006), "Effectiveness and Feasibility of Innovative Freight Strategies for the U.S. Urban Areas", In Recent Advances in City Logistics: Proceedings of the 4th International Conference on City Logistics, pp.191-205, Elsevier.

[39] Kinver, (2011): http://www.bbc.co.uk/news/science-environment-14121360

[40] Kvale, S., and Brinkmann, S. (2009), "*InterViews: Learning the craft of qualitative research interviewing",* SAGE Publications Ltd. USA.

[41] Lieb, K. J., and Lieb, R. C. (2010) "Environmental sustainability in the third-party logistics (3PL) industry", *International Journal of Physical Distribution & Logistics Management*, Vol. 40, No. 7, pp. 524-533.

[42] Lindholm, M. (2008), *A sustainable perspective on urban freight transport: factors and incentives affecting local authorities in the planning procedures*, PhD Dissertation, Chalmers University, Gothenburg, Sweden.

[43] Ljungberg, D. and Gebresenbet, G., (2004), "Mapping out the potential for coordinated goods distribution in city centres: The case of Uppsala", *International Journal of Transport Management*, Vol. 2, No. 3-4, pp. 161-172.

[44] MacLean, R. (2010), "Checking the sustainable development box", *Environmental Quality Management*, 19, 3, pp. 103-112.

[45] Marcucci, E., and Danielis, R. (2008), "The potential demand for a urban freight consolidation centre", *Transportation*, Vol. 35, No. 2, pp. 269-284.

[46] Markus, H., (2006), "Global Chain, Local Pain: Regional Implications of Global Distribution Networks in the German North Range", *Growth and Change*, Vol. 37, No. 4, pp. 570-596.

[47] McKinnon, A., Cullinane, S., Browne, M., and Whiteing, A. (2010), *Green Logistics: Improving the environmental sustainability of logistics*, Kogan Page Limited, UK.

[48] Munuzuri, J., Larraneta, J., Onieva, L., and Cortes, P. (2005). "Solutions applicable by local administrations for urban logistics improvement", *Cities*, Vol. 22, No. 1, pp. 15-28.

[49] Munuzuri, J., Cortes, P., Onieva, L. and Guadix, J. (2010), "Modelling peak-hour urban freight movements with limited data availability", *Computers & Industrial Engineering*, Vol. 59, No. 1, pp. 34-44.

[50] Patier, D. and Browne, M. (2010), "A methodology for the evaluation of urban logistics innovations, *Procedia Social*

and Behavioral Sciences, Vol. 2, pp. 6229-6241.

[51] Patton, M.Q. (2002), *Qualitative Research & evaluation Methods*, 3rd Edition, Sage Publications, Inc., USA.

[52] Pawlak, Z. and Stajniak, M. (2011), "Optimisation of transport processes in city logistics", *LogForum*, Vol. 7, No.1.

[53] Petersen, T. (2006), "Development of a city logistics concept", *Production Planning & Control: The Management of Operations*, Vol. 17, No. 6, pp. 616-623.

[54] Qiang , L. and Miao, L. (2003), "Integration of China's intermodal freight transportation and ITS technologies", *Intelligent Transportation Systems*, Vol.1, pp. 715-719.

[55] Quak, H.J., de Koster, M.B.M. (2007), "Exploring retailers' sensitivity to local sustainability policies", *Journal of Operations Management*, Vol. 25, No. 6, pp. 1103-1122.

[56] Quak, H.J., and Tavasszy, L.A. (2011), "Customized solutions for sustainable city logistics; the viability of urban freight consolidation centres", in van Nunen, J.A.E.E., Huijbregts, P., Rietveld, P., *Transitions towards sustainable mobility – New Solutions and Approaches for Sustainable Transport Systems*, Springer Heidelberg Dordrecht, London, New York.

[57] Rambaldi, L. and Santiangeli, A. (2011), "Innovative design of a hydrogen powertrain via reverse engineering, *International Journal of Hydrogen Energy*, Vol. 36, No. 13, pp. 8003-8007.

[58] Rogers, E.M. (2003), *Diffusion of Innovations – 5th edition*, New York: Free press.

[59] Shrivastava, P. (1995), "The role of corporations in achieving ecological sustainability", *Academy of Management Review*, Vol. 20 No. 4, pp. 936-960.

[60] Taniguchi, E., and Van Der Heijden, R.E.C.M. (2000), "An evaluation methodology for city logistics", *Transport Reviews: A Transnational Transdisciplinary Journal*, Vol. 20, No. 1, 65-90.

[61] Toh, K.T.K., Nagel, P. and Oakden, R. (2009), "A business and ICT architecture for a logistics city", *International Journal of Production Economic*s, Vol. 122, No. 1, pp. 216-228.

[62] United Nations 2005 World Summit outcome, (2005), *Sixtieth session – Items 48 and 121 of the provisional agenda (A/60/150).*

[63] Van Duin R., and Van Ham H. (2001), "A three-stage modeling approach for the design and organization of intermodal transport services", in Proceedings of the IEEE International Conference on Systems, Man and Cybernetics, Part 4, October 11-14, 1998, San Diego, CA, USA.

[64] van Rooijen, T., and Quak, H.J. (2008), "Local impacts of a new urban consolidation center – the case of Binnenstadservice.nl", *Procedia Social and Behavioral Sciences*, pp. 1-13.

[65] Waddell, P., Liming W., and Xuan L. (2008), "UrbanSim: An Evolving Planning Support System for Evolving Communities" in Brail, R. (Ed.), *Planning Support Systems for Cities and Regions*, Cambridge, MA: Lincoln Institute for Land Policy, pp. 103-138.

[66] Weber, K.M. (2003), "Transforming Large Socio-technical Systems towards Sustainability: On the Role of Users and Future Visions for the Uptake of City Logistics and Combined Heat and Power Generation", *Innovation: The European Journal of Social Science Research*, Vol. 16, No. 2, pp. 155-175.

[67] Wigan, M. and Southworth, F. (2004), "Movement of goods, services and people: entanglements with sustainability implications", *STELLA FG4 meeting*, Brussels, Belgium.

[68] Yamada, T., and Taniguchi, E. (2006), "Modelling the effects of City Logistics schemes", in E. Taniguchi and R.G. Thompson (eds.), Recent Advances for City Logistics, Proceedings of the 4th International Conference on City Logistics, Langkawi, Malaysia, 12-14 July, 2005, Elsevier, 2006, pp. 75-89.

[69] Yoshizumi, K., Inoue, K., Nakamura, K., and Miyoshi, K. (1982), "Diesel emission characteristics on urban driving cycles", *Environmental Pollution. Series B, Chemical and Physical*, Vol. 4, No. 3, pp. 165-179.

[70] Zeimpekis, V., Giaglis, G.M., and Minis, I., (2008), "Development and Evaluation of an Intelligent Fleet Management System for City Logistics", in *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*.

[71] Zuccotti, S., Corongiu, A., Forkert, S., and Naser, A., (2011), "Integrated infomobility services for urban freight distribution", *2011 IEEE Forum on Integrated and Sustainable Transportation Systems*, pp. 306-311.

[72] Zwetsloot, G.I.J.M. (2003), "From management systems to corporate social responsibility", *Journal of Business Ethics*, Vol. 44 Nos 2/3, pp. 201-207.