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RELATIONSHIPS AMONG ECONOMY, LAND-USE AND ENVIRONMENT IN URBAN FREIGHT MOBILITY

L'INTERRELAZIONE TRA ECONOMIA, TERRITORIO E AMBIENTE NELLA MOBILITÀ URBANA DELLE MERCI

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ABSTRACT - SOMMARIO

Freight transportation maintains a set of core relations with urban areas since a city is an entity where production, distribution and consumption activities are and use limited land. Urban economies are evolving rapidly towards a higher of material intensiveness. In fact, cities represent multiple dimensions of human activity from economic, social, political and cultural standpoints. In these years, the store inventory levels have shrunk and businesses are increasing their restocking activities based on the *just-in-time* concept. Following these changes, the demand of express transport and courier is also soring. All these factors have made a strictly relation between urban economies and transportation systems, characterized by more frequent and customized deliveries. Furthermore, the urban freight transport is performed by road that is the most polluting per unit of distance travelled. In this context, city logistics, as *the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption*, is an emerging field of investigation that was brought by the new urban challenges.

The paper analyses the existing relationships within the urban contexts, and describes a general methodology that should be used for analyzing such a system.

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1 Introduction

Due to their large populations and extensive commercial establishments, urban areas require large quantities of goods and services for commercial and domestic use. The growing importance of urban freight transport is related to increases in urban populations and continued economic growth in urban areas (Browne *et al.*, 2012). In fact, in the urban and metropolitan areas more than 50% of worldwide population lives. In Europe, this share increases and reaches the 75% (ISPRA, 2009). Store inventory levels and the increasing of number of different products sold have pushed the urban economies to be more dependent on transportation systems, with more frequent and customized deliveries. But, in the urban planning process the role of goods movement has often been ignored. In fact, traditionally, several aspects related to passenger mobility are pointed out when a good quality of life in the city is wanted to reach.

Land-use and zoning decisions at the local level, by determining the location of the origin or destination of goods, as well as restrictions on time and routes followed, often occur without a full understanding or consideration of urban goods movement by commercial motor vehicles. As a consequence, the logistical needs of businesses and consumers may be degraded, opportunities for economic development may be missed, and freight movements may unnecessarily detract from the quality of life through congestion or emissions (NCFRP, 2012).

Therefore, we have to note that all towns and cities require the supply of goods and services, and the removal of waste products and hence are dependent on urban freight transport. There are similarities and also many dissimilarities (Nuzzolo *et al.*, 2012) in the nature of these freight operations between urban areas across the world. However, some variations exist depending on urban attributes including: the type and quality of transport infrastructure, the degree of vehicle motorisation, the prevailing traffic levels, the degree of automation in vehicle loading/unloading and materials handling, the extent of freight transport regulation by government, and the organisation and operation of waste collection services (Dablanc, 2010).

The freight transport is a fundamental component of urban life. Every day, citizens consume and use goods (e.g. food, clothes, furniture, books, cars, computers) produced by people throughout the world. Urban goods transport enables citizens to have access to these products wherever and whenever they require. Then, a planning process devoted to improve the city attractiveness and the quality of life (i.e. city sustainability) cannot leave out of consideration the role of freight transport, differently as today happens where most of the resources at the city level are focused on public transport and cars (Behrends *et al.*, 2008).

It is also important to be noted that implementation of one or a set of measures can be considered a rational decision-making process and can have different temporal scales:

- *strategic horizons* involve decisions on long-term capital investment programs for the realization of new infrastructures (e.g. urban distribution centres, roads) and/or the change of vehicles and technologies (e.g. environment-friendly vehicles and control systems); these actions could determine modifications both on retail and wholesale activity systems; the model should capture the transport and land-use interactions;
- short/medium term *tactical* implementation is concerned with decisions on projects requiring limited resources, usually assuming minor changes (or none) in infrastructures (e.g. loading and unloading zones, road-pricing); the models should mainly support the design of urban freight transportation system;
- short-term *operative* programs can include the implementation of some measures/policies that regard particular aspects of governance (e.g. time windows); the model should mainly point the simulation of urban freight transportation system.

The paper, starting from the identification of actors, externalities due to freight transport in urban areas and measures to be implemented in order to improve the city sustainability (section 2), describes the existing relationships among economy, land-use and environment in the urban freight mobility through a general modelling architecture. This modelling framework allows us to simulate the different implementable city logistics scenarios in order to reduce the impacts of freight traffic without penalizing the city life (section 3). The state-of-the-art is hence proposed. Finally, some conclusions are given in section 4.

2 Urban Freight Transport

2.1 Actors and externalities

The urban goods movements are the result of a set of long and short-term choices made by: inhabitants/customers, retailers, wholesalers, carriers and local authorities. Inhabitants/customers decide where to buy, as well as the mode of transport to use, retailers decide the shop location and where to bring the freight sold in the shops, wholesalers, logistics operators and distributors choose their location and how to restock retailers, while carriers decide the delivery process. Finally, city administrations try to govern the overall process aiming to minimize the global cost of the system, made of distribution inner costs, inhabitant transportation costs for shopping, congestion costs and external ones (pollution and road safety).

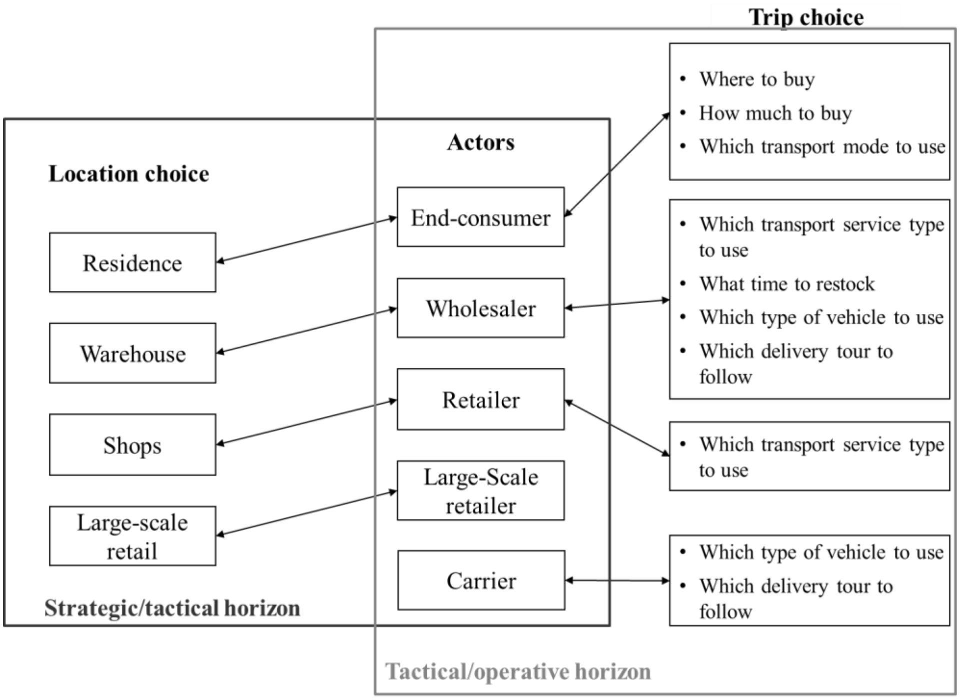

Fig. 1 – Actors' choices

Urban freight transport thus plays an essential role in meeting the needs of citizens, but at the same time contributes significantly to the non-sustainable effects on the environment, economy and society. It is on average twice as polluting than intercity freight transport, particularly because of the following factors (Rodrigue and Dablanc, 2009):

- *sprawl* of origin and destination; several attractive activities are located within urban areas, and pushed to offer a large variety of products and to have a wide array of supply chains; then, they determine a large number of freight flows that are not always optimised;
- *vehicle age*; on average vehicles used for urban deliveries are older and it is a common practice to use trucks at the end of their service life for short distance drayage;
- *vehicle size*; the size of vehicles used for urban deliveries is on average smaller, particularly in areas that have high density and limited street parking; this implies that the advantages of economies of scale cannot be effectively applied for urban freight distribution;
- *operating speeds and idling*; the conditions pertaining to urban freight distribution are such that vehicles are forced to have lower driving speeds, regular stops and acceleration (e.g. traffic signals) as well as much more idling than a vehicle operating in an uncongested environment; the result is more fuel consumption and pollutant emissions.

Furthermore, we have to consider that the passenger for shopping prefer private vehicle causing the increasing of congestion and, then, of internal and external costs. Reduction of sprawl could reduce freight distribution costs, but, at the other hand, it increases the shopping mobility costs (Figure 2).

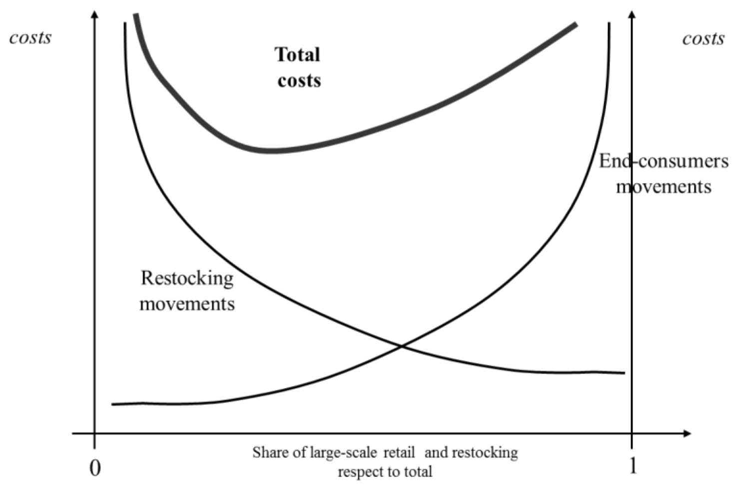

Fig. 2 – Internal and external costs due to urban freight transport

Then, local administrators are looking at city logistics measures in order to reduce the negative effects of freight transport within their cities, considering that feasible solutions have to be an optimal compromise between the various interests concerned (Stathopoulos *et al.*, 2011). They have to pursue two different classes of strategies: one related to freight distribution and one to shopping mobility. For what concerns freight, they need to:

- reduce driving commercial vehicles,
- increase the use of light and environment-friendly vehicles,
- optimise loading and unloading operations in order to reduce traffic congestion,
- reduce the interferences with the other component of urban mobility (e.g. pedestrians).

Related to shopping, they have to:

- reduce the driving private vehicles,
- increase the use of transit, cycling and walking
- reduce the shopping travel distance, increasing the use of nearby commercial area.

These goals can be reached by implementing a set of city logistics measures, which are synthetizes in the next section.

2.2 City logistics measures

In order to solve the impacts due to freight transport and to improve city sustainability, sets of city logistics measures can be implemented (BESTUFS, 2007; Russo and Comi, 2011). The available measures can be grouped in relation to planning horizons (strategic-tactical and tactical-operative) and if they mainly refer to freight distribution or shopping mobility (Table 1). In the following the tactical-operative horizon will be deepened.

Table 1 – City logistics measures and planning horizons

	Freight Distribution	Shopping mobility
Tactical/Operative horizons	• Freight demand management • Telematics • Urban freight distribution organization: Nearby Delivery Area	• Travel demand management • Increasing of Limited Traffic Zones and pedestrian areas
Strategic/Tactical horizons	• Urban freight distribution organization: Transit Point & Urban Distribution Centre • Railway transport • Design standards • Urban Infrastructures • Land-use and zoning • Cooperation	• Improving the public transport services • Transit Oriented Development

2.2.1 Freight transport

The *freight demand management* refers to the application of strategies and policies to reduce travel demand, or to redistribute this demand in space or in time; examples are:

- time windows, consisting of regulations on time window access;
- loading/unloading areas, consisting of defining some constraints for use of specific areas for handling operations;
- vehicle access constraints (e.g. on pollutant emissions and weight), consisting of definition of some constraints for access that could be in terms of emission standards (e.g. Euro I) or vehicle dimensions (e.g. weight less than 3.5 tons);
- route restrictions, consisting of definition of sub-network only for trucks or permission to use bus line;
- area-pricing, consisting of access charging; it is based on two main principles: all those willing to pay have access (payments are possibly subject to exemptions and discounts for certain categories); only certain user categories are granted access and have to pay a charge for it;
- incentives, consisting of creating incentives to use transport on third party that should be more efficient than transport on own account; incentives to use less polluting vehicles or even to renew the vehicle fleet are also considered.

Telematics refer to Intelligent Transportation Systems (ITS) that may both improve effectiveness (in terms of high service levels) and efficiency (in terms of cost reduction) of logistics flows, and reduce negative externalities, also improving enforcement effectiveness and broadening the scope of enforcement.

The *urban freight distribution organization* refers to actions related to optimize the deliveries within the urban area, so that externalities can be reduced because of reduction of travelled kilometres and increasing of commercial speed; examples are giver by:

- nearby delivery area/transit point, consisting of urban transhipment platform on which dedicated staff provides assistance for the dispatching of consignments for the last mile by trolleys, carts, electric vehicles and bicycles;
- urban consolidation/distribution centre, consisting of infrastructural solution that can support modal shift (e.g. city terminal, outskirts logistics centre, rail or ship terminal) or cooperation among actors (e.g. mini-warehouse).

The *railway transport* refers to use the existing rail infrastructures (e.g. tram network) in order to transport freight within urban areas.

Design standards are typically regulated by local government planning. Design standards relevant to urban goods movements deal with issues such as the number, location, and design of loading docks and freight elevators, as well as parking lots and related facilities on the site (NCFRP, 2012).

Urban infrastructures consider that older urban intersections, narrow streets, and alleyways may restrict truck mobility causing trucks to hit poles or signs located on corners or to drive over sidewalks to make turns. Then, solutions have to be investigated.

Land-use and zoning point out that urban areas are made up of a variety of land-uses covered by various zoning regulations, each with unique goods movement needs and impacts: urban city center/central business district (CBD), urban residential area, urban manufacturing district, and first-ring suburb (NCFRP, 2012).

Cooperation refer to reduce impacts that one of the most typical characteristics of carriers and logistic operators is their independence within a very competitive environment. the idea is to have a single carrier (the common carrier) that makes a collection round of all the goods to be transported by different carriers, and then delivers them at their final destinations. The possibility to have joint deliveries or joint receptions can be also pointed out (Munuzuri *et al.*, 2005).

2.2.2 Shopping mobility

The travel demand management actions mainly refer to *limitation of private vehicles* which promote the use of transit; example are:

- parking fees; the price of parking may be used to influence travel choice by altering the cost of private vehicle travel, and hence its attractiveness, relative to travel alternatives including transit;
- access constraints for specific areas; the strategy is to discourage or prohibit private car use in the core and gradually relax these restrictions outside the core.

The *increasing of pedestrian areas* (also known as auto-free zones and car-free zones) consists of having areas of a city or town reserved for pedestrian only use and in which some or all automobile traffic may be prohibited. Furthermore, *promotion of nearby commercial areas* should be also pursued in order to improve the attractiveness of non-inner areas through the promotion of opening of new shops.

3 Urban freight transport modeling framework

A general methodology able to simulate the urban freight transport, useful for study the relationships among the different aspects of urban context, should consist of a set of tasks able to (Comi *et al.*, 2012):

- forecast how the key land-use activities (business and employment, housing and population/households), the use of transport systems, and associated markets may be expected to change over time, taking account of the transport infrastructure and its performance (Land-Use Transport Interaction - LUTI - models);
- forecast the freight quantities requested by end-consumers through the simulation of shopping mobility;
- simulate the distribution process of different involved decision-makers (e.g. retailers, wholesalers, carriers; demand models; Nuzzolo and Comi, 2011);
- represent the transportation infrastructures with their operation characteristics (supply models) and how to modify supply in order to optimize given objectives while satisfying given constraints (design/what to models);
- assign the multi-commodity flows to the multimode network (assignment models);
- estimate and evaluate the performances and the impacts of a given city logistics scenario (performance model).

This described methodology provides to simulate the behavior of the transportation system and its output forms the basis for the strategic, tactical and operative analysis. These methodologies are quite well known for regional/national planning and only in the recent years the urban and metropolitan freight transport scale has been pointed out. In this context, the paper focuses on the existing relationships and investigates which are the current tools for this aim, identifying also the limits of actual state-of-the-art. In particular, the paper covers three main areas of research: models for simulating urban freight transportation system, models for simulating land-use and transport interactions, models for estimating performances and impacts.

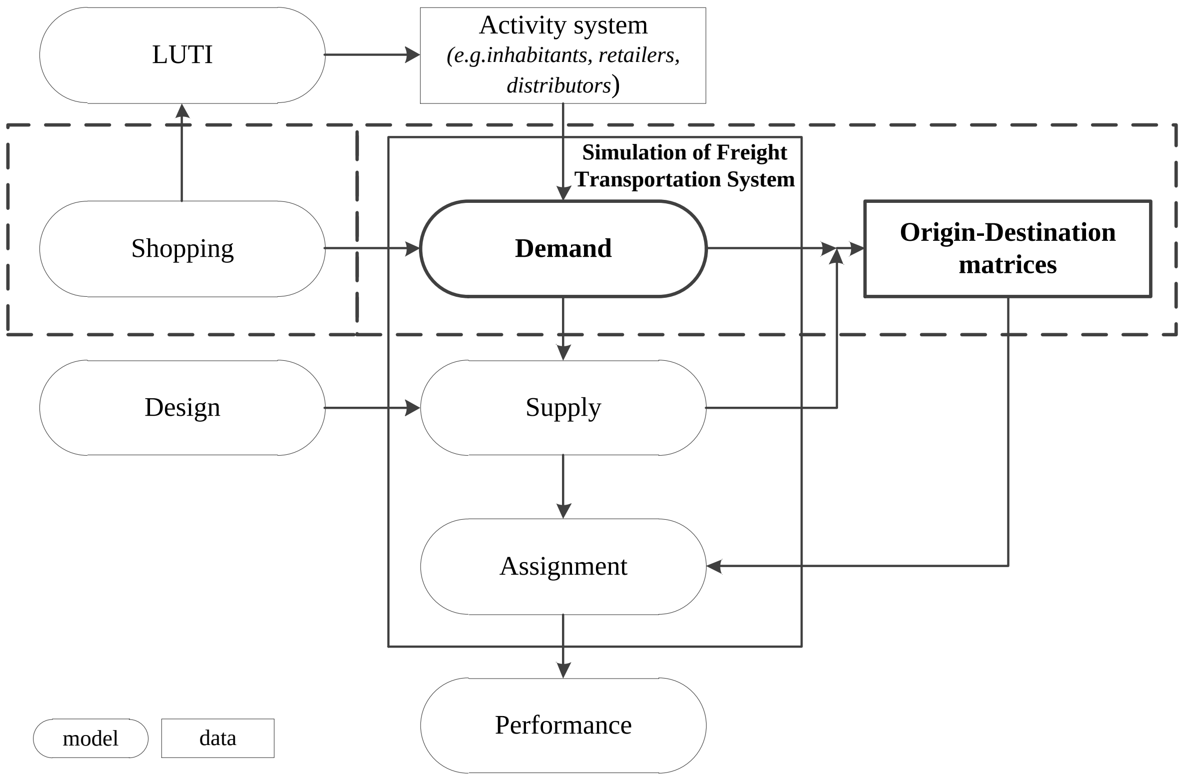

Fig. 1 – Urban freight transport modelling structure.

3.1 Freight transport system

The recent and sophisticated systems of models for freight transport simulation have resulted from the integration of two classes of them: models to simulate the level and spatial distribution of commodity flows exchanged within the study area (*demand*; intra-city Origin-Destination matrices), and models which simulated the *path choice* and, then, the *traffic assignment* to the transportation network.

Even though several classifications have been proposed (Ambrosini and Routhier, 2001; Ambrosini *et al.*, 2008; Chow *et al.*, 2010), an extension of that proposed by Ogden (1992) and Taniguchi *et al.* (2001) consists of classifying the demand models in relation to the reference unit of quantity or delivery moved (commodity-based and delivery-based, respectively) or freight vehicle by which transport is made (truck-based) or mixed commodity/delivery-based (Comi *et al.*, 2012).

Although truck-based models estimate directly O-D trips of freight vehicles, they are suitable to be used for the simulation of the current scenario, but they can difficultly to be applied in forecasting analysis. Truck-based models have the advantage of the ease of data gathering (e.g. using automatic traffic counts) which facilitates the calibration and validation, but they are not able to account properly for changes in the mechanisms underlying demand

generation. Another difficulty of the truck-based models relates to the treatment of scenarios where modes other than road are considered.
Commodity-based models consider as reference unit the quantity of commodity. The estimation of vehicle O-D matrices by these type of models is carried out by a sequence of models: attraction model (which provides the commodity/quantity flows attracted by each zone generally in function of socio-economic data; Gonzalez-Feliu *et al.*, 2010; Russo and Comi, 2012), acquisition model (which provides the zone from where the commodity/quantity flows are originated), quantity-to-vehicle model (which receives as input the commodity/quantity O-D flows and converts them into vehicles). These models have reached a quite good maturity, but few authors propose a complete modelling framework (Russo and Comi, 2010; Nuzzolo *et al.*, 2010). The proposed models mainly investigate some specific stages, e.g. attraction and distribution, transport service type.
The delivery approach focuses on movements/deliveries (pick-ups and deliveries); the use of delivery as reference unit allows to have a direct link between generators and transport operators through the use of the same reference unit. The models proposed within the delivery-based approach consist of a sequence of statistic-descriptive models (Routhier and Toilier, 2007; Muñuzuri *et al.*, 2012). Then, they are able to reproduce the actual scenario, but they fail in forecasting analysis in which the effects of city logistics measures should be assessed. Therefore, based on the statement that the current literature does not enough investigate the direct relation between measures and models, Nuzzolo *et al.* (2010) and Nuzzolo and Comi (2012) proposed a new modeling system that allows us to point out each choice that could be influenced after city logistics scenario implementation.

Referring to *path choice* and *assignment* models that allow us to obtain the link freight flows, the proposed solution are quite similar to those developed for passenger travel. The main difference between route choice models for passenger and freight traffic is that the network might be different because there are links which have restrictions for freight vehicles. The choice of route by truck drivers within an urban network may be constrained by the vehicle size, but there are also other important factors that tend to influence the route choice behaviour of freight drivers in urban area including driver, vehicle and route (Stern *et al.*, 1983; Yeomans and Balce, 1992; Bitzios and Ferreira, 1993). At the other hand, the assignment procedure for freight have been pointed out within the operational research field. In fact, in a number of studies vehicle routing models are proposed to obtain link freight flows (Taniguchi *et al.*, 2001; Toth and Vigo, 2002; Lapierre *et al.*, 2004; Taniguchi *et al.*, 2007; Russo *et al.*, 2010; Gonzalez-Feliu, 2010). The main objective of this type of models is to deal with the vehicle assignments and the best possible routing, which can be used in the case of one operator or distributor. From a transport planning point of view this technique presents some limitations as it attempts to model individually the operators within an urban area, each of them with own behaviour, distribution strategy and, thus, perceived costs.

We find few studies treating the overall problem of urban freight transport simulation including *shopping mobility*. Existing models mainly simulate some aspects of the restocking process and few of them considers the possibility of combining freight and passenger flows (Oppenheim, 1994), hence of representing the interacting behavior of commodity consumers and commodity suppliers/shippers/retailers. Thus, there are difficulties forecasting the impacts and simulating the effects of transportation measures on an urban scale. The end-consumer movements are mainly studied within the passenger mobility and few studies have considered them belonging to urban freight distribution as the final part of supply chain (Russo and Comi, 2010; Gonzalez-Feliu *et al.*, 2010; Russo and Comi, 2012). In fact, as several surveys have confirmed (Nuzzolo *et al.*, 2010; Comi *et al.*, 2011) the freight arrives to urban area mainly for satisfying the end-consumers' demand. The traditional demand studies are dominated by work-related trips (Cascetta, 2009), thus issues that are relevant for shopping purposes (e.g. suitability and practicability of transportation modes) are often ignored.

3.2 Land-use and transport interactions

Land-use patterns determine many features of the urban movement of goods. The spatial distribution of industrial, commercial and logistics facilities has a direct impact on the number of vehicle-kilometers that will be necessary to reach the stores, industries and households that need to be supplied. A majority (more than two thirds in the case of European cities) of all shipments to and from urban areas are organized from terminals and distribution centers located in proximity. These terminals are key elements of the urban freight system. Logistics sprawl is the spatial deconcentration of logistics facilities in metropolitan areas. Confronted with the severe land pressure in large cities, as well as with the large urban renewal projects that took place in the city during the 1960s and 1970s, logistics and transport companies began to follow a centrifugal locational pattern. The physical moves were done by small-scale changes in their spatial organization, with the closing of urban terminals and the opening of new ones further away (Rodrigue *et al.*, 2009).
Although movements of freight are mostly driven by the private businesses, the public sector decisions have critical and pervasive effects on the means and efficiency of freight movement (Miodonski and Kawamura, 2012). Land-use decisions, implemented through regulations and local ordinances, affect the design and management of supply chains, including the placement of facilities. Furthermore, land-use determines the location and intensity of demand for freight movements. Recently, land-use and transportation policies known as Smart Growth have

dominated regional and local planning practices in the U.S. (Miodonski and Kawamura, 2012; Wygonik *et al.*, 2012). However, in most cases, the impacts of land-use and urban design on the flow of goods are not examined, or even considered by the planners or policy makers. In fact, according to Bronzini (2008), "the goods delivery impacts are viewed as ancillary effects rather than primary planning goals".

Urban density and design can have profound impacts on both the volume and efficiency of freight movements for the *last mile* segment of journey. Also, while many cities strive to gentrify urban core areas with densification and transit-oriented development (TOD), very little attention is paid to the fact that such land-use pattern may lead to an increase in the intensity of goods consumption per a unit of land area. Meanwhile, it is also plausible that compact land-use pattern reduces the consumption of freight because of the need to reduce inventory space, and thus the overall intensity of freight demand per unit area may actually decreases with density. A study by Kawamura and Lu (2006) found that the demand for freight, measured in annual tons per capita or ton-miles per capita, varies significantly among countries. For example, they found that Italy has a considerably lower average annual ton per capita than other European countries and the U.S. They also found that the freight ton-miles per capita for the U.S. was as much as three times greater than those for most of European countries.

For passenger travel, the relationships between travel behavior and built environment (e.g. land use allocated for different industrial types, density) as well as socioeconomic characteristics have been studied extensively, e.g. Nuzzolo and Coppola (2005), Simmonds and White (2005), Wenban-Smith (2009), Ewing and Cervero (2010). Therefore, the same should be done for freight mobility. In fact, an integrated land-use design should be pursued in order to reduce the travel distances for both passenger (that move to buy) and freight (that mainly are moved to satisfy the end-consumer demand).

Then, few studies have investigated the impacts of truck travel in mixed-use environmental. The relative benefit of trip reduction resulting from mixed-use environments should be compared to the benefit of allowing off-hour service by truck (Wygonik *et al.*, 2012). Currently, the research is mainly investigating the relationships between truck trip and built environment (McCormak and Bassok, 2011; Kawamura and Miodonski, 2012).

3.3 Performances and impacts

Both mobility and travel choices are influenced by some characteristics of the offered transportation services. These characteristics are known as level-of-service or *performance* attributes and include travel times, monetary costs, service reliability, etc. Thus, the choice of acquisition zone may be influenced by the travel time and cost needed to reach each warehouse. The choice of departure time of delivery journeys depends on the travel time to

the destination and the constraints given by receivers (i.e. retailers). The choice of transport service type (e.g. on own account or third party) is influenced by times and costs.
The transportation performances influence the relative accessibility of different zones of the urban area by determining, for a given zone, the "cost" of reaching other zones ("active" accessibility), or being reached from other zones ("passive" accessibility). As has been noted, both these accessibilities influence the location of economic activities (e.g. warehouses) and ultimately the real estate market (Cascetta, 2009).
The effects of a transportation system project are usually represented by a set of variables known as impact indicators or measures of effectiveness (MOE). Since, in general, there are several elemental impacts, and it is impractical to handle all the related variables, it is common practice to use for further analyses a reduced number of performance indicators obtained as aggregate variables, or "intermediate constructs".
Some impact indicators are quantitative variables such as travel time or CO tons of gas emissions; others are "structurally" qualitative and can, at most, be expressed by descriptive variables (adverbs such as 'little', 'much', etc.) or on an arbitrary scale (such as from A to F).
In order to identify solutions for the design problem, it is necessary to evaluate the system responses (demand, flows and performances) to the possible actions; therefore the impact or performance model provide a core modeling function for predicting the impacts of implementing city logistics scenarios. These models should be used to estimate a wide range of impacts (Taniguchi *et al.*, 2001):

- Social impacts by alleviating traffic congestion and crashes;
- Economic impacts due to changes in fixed costs and operation costs;
- Environmental impacts in terms of pollutant and noise emissions;
- Financial impacts by reducing costs to carriers and shippers;
- Energy consumption by changing the amount of energy used.

A key challenge for transportation agencies is to improve the efficiency of urban freight and commercial vehicle movements while ensuring environmental quality, livable communities, and economic growth. Research in the area of city logistics has long recognized the need for a balanced approach to reduce shippers' and carriers' logistics cost as well as community's traffic congestion and environmental problems (Taniguchi *et al.*, 2003, Crainic *et al.*, 2004). The research devoted to investigating the impacts of congestion on urban commercial vehicle operations and time dependent travel times is relatively poor. In the existing literature, there are few published studies on this topic (Taylor and Button, 1999).
Congestion has a significant impact on delivery journey where delivery times are heavily restricted by customer time windows and schedules. In addition, there may be a fairly inelastic relationship between delivery costs and customer's demand characteristics and levels. For example, Holguin-Veras *et al.* (2006) investigated the effects of New York City's congestion pricing on deliveries and found little changes because delivery times were

determined by customer time windows and schedules. Figliozzi (2007, 2009) analyzes the effects of congestion on vehicle tour characteristics using continuous approximations to routing problems. Figliozzi (2007) analyzes how constraints and customer service time affect trip generation using a tour classification based on supply chain characteristics and route constraints. This work also reveals that changes in both vehicle kilometers traveled (VKT) and vehicle hours traveled (VHT) differ by type of tour and routing constraint. Quak and Koster (2009) utilized a fractional factorial design and regression analysis to quantify the impacts of delivery constraints and urban freight policies. Holguin-Veras *et al.* (2012) discuss the economic impacts of off-hour deliveries in the city of New York.

There is a wide literature on environmental impacts. A general overview is offered by Taniguchi *et al.* (2001). Referring to noise, we should note that there are a number of factors that affect the noise level generated by traffic at a given distance from road. The noise level is represented as a function of traffic volume, ratio of heavy vehicle. In relation to pollutant emissions, traditionally the current literature proposes regression models that allow us to estimate emissions in function of several factors, including type of vehicles, average travel speed, type of road, travelled kilometers (Filippi *et al.*, 2010). Within this class of impacts, traffic-induced vibration is sometimes considered. In fact, it could produce serious problems to people and houses. For example, the traffic environment manual in Japan (Taniguchi *et al.*, 2001) proposes to estimate the traffic-induced vibration in function of traffic characteristics, average travel speed and characteristics of road.

Financial modeling is important for evaluating the feasibility and profitability of a project related to urban freight transport. As usually happens, projects can be evaluated through cost-benefit analysis. At the other hand, financial models play an important role in determining whether or not to implement city logistics scenario. Sometimes profitability analysis reveals that implementation require financial support from the public sector (Nuzzolo *et al.*, 2008). The reasons could be that projects related to city logistics often cannot internalize the positive external economy and require a large initial investment.

Finally, city logistics scenarios can affect energy consumption of freight vehicles by improving and rationalizing urban freight transport systems. There are several factor that can influence fuel consumption, among these we have running pattern (e.g. average travel speed and driver behavior), road conditions (e.g. surface quality, slope), vehicle conditions another effect (e.g. fuel type, whether conditions). Example of model developed for estimating fuel consumption can be found in Kraus (1998).

4 Conclusions

Over the past several decades, there has been considerable research devoted to urban freight mobility modeling. Much of this emphasis is an outcome of the recognition that freight transportation and economic development are inextricably linked to one another. This paper has attempted to review and synthesize various modeling approaches for freight transportation planning. Generally, the different aspects of urban goods movements (e.g. economy, land-use and transport) are not analyzed in an integrated manner. Then, the paper describes a general framework able to integrate the actual models developed mainly to simulate only a specific aspect of urban mobility. The main characteristic of this general framework is the representation of interacting behavior of all actors and of all generated impacts. It allows to simulate goods movements at urban scale combining passenger shop travelling and commodity flows, and taking into account the mechanism of the localization of freight centers/platforms and shopping centers. The above study could be move to reach further goals including the study of the dynamic evolution of interactions for both short and long-term effects through the applications to real cases: the short-term effects consider the behavioral purchase process of customers. The long-term effects can be taken into account transport/land-use interactions trough LUTI-type modelling, mainly developing models of localization of urban distribution centers and large shopping centers.

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