AN EMPIRICAL ANALYSIS OF RESULTS OBTAINABLE FROM CITY LOGISTICS MEASURES

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Abstract
This paper presents an ex-post assessment review of city logistics measures. The recalled measures are classified and analysed in terms of involved actors, temporal reference scale and results obtained in different cities around the world.
In order to analyse measures before their implementation for an ex-ante assessment of reachable impacts, in literature some modelling systems have been proposed. In the paper, recalling the modelling system developed by authors some results and indications obtained by calibration and validation phases are given.

1. INTRODUCTION

Today, there is a worldwide focus on setting up a Sustainable Development Strategy to identify and define measures to achieve a continuous long-term improvement in quality of life by creating sustainable communities able to manage and use resources efficiently, use the ecological and social innovation potential of the economy and in the end ensure prosperity, environmental protection and social cohesion. In this context, development must be characterized by the definition of economic, environmental and social sustainability.

In the urban and metropolitan areas lives about of 75% of population which consumes about the 70% of energy and produces about the 80% of GHG emissions. The urban transport accounts for about the 32% of energy consumption and for about the 40% of CO_2 emissions (ISPRA, 2009). A substantial share of traffic is given by goods movements. In fact, as confirmed by several empirical studies the total urban freight vehicles account for 6 – 18% of total urban travel (Cambridge Systematics, 2004; Hunt *et al.*, 2004; Stefan *et al.*, 2005) and for 14% of vehicle-kilometres, 19% of energy use and 21% of CO_2 emissions (Schoemaker *et al.*, 2006). According to the Civitas project in some European cities the share of commercial vehicles makes up 30% of the total travelling vehicles (Becker *et al*., 2008). It has to be noted that urban freight is more polluting than long-distance freight transport owing to the frequency of short trips and stops. Fuel consumption increases sharply if the vehicle has to stop very often: with five stops in 10 km, fuel consumption increases by 140% (Martensson, 2005).

In this context, many city administrators have implemented measures to mitigate the negative effects of freight transport but many of them have not given the expected results, as confirmed by several ex-post analysis. Several authors have verified that one of main problems is given by the lack of interest by local authorities for this segment of mobility that have determined a shortage of data Browne e*t al.* (2007).

Starting from an analysis of existing studies relative to freight policies implemented at urban scale in Europe, the paper proposes an analysis of results obtainable from the implementation of different city logistics measures. The city logistics measures will be analysed in terms of actors/decision-makers involved, temporal reference scale (strategic, tactical, and operative) and results obtained in different cities. Referring to sustainable development, although many indicators can be found with different goals and outcomes in the literature, but in a compact way in the paper, we assume that economic and social sustainability can be treated in terms of efficiency and safety, and environmental sustainability in terms of air pollution. Importantly, the objectives of sustainable development can be obtained by measures that are sometimes conflicting, and generate impacts that are influenced by the acceptance of stakeholders and external factors. From analysis, it emerges that many measures are related to economic and environmental sustainability, while few can be attributed to social sustainability (e.g. road safety).

The global problem of urban freight transport simulation has been extensively treated elsewhere, with attempts to identify homogeneous freight movements in urban and metropolitan areas and relative decision-makers (actors); the complete problem of city logistics from the end-consumer to the producer has been rarely tackled. In this paper we refer to the assumptions of Russo and Comi (2007) who propose an integrated modeling system that allows linkage between end-consumer choices and restocking choices made within the urban or metropolitan area. The results obtained in the calibration and validation phases based some *ad hoc* surveys to end-consumers and retailer are resumed. These results give some preliminary and empirical indications on how city logistics measures can modify the Level of Service Attributes (e.g. generalized travel cost) and, thus, the actors' choices involved in the urban freight transport.

The proposed analysis of measures refers to an *ex-post* assessment, but their effects could be evaluated before by using suitable models, e.g. the integrated system of models developed by the authors. At this aim, the paper also gives some empirical indications obtained by the validation of the developed modelling system. The movements and decision-makers/actors of urban freight transport area analysed in the section 2; the section 3 summarises the implementable city logistics measures investigating how each of them can impact on each actors and resuming which are the main obtainable results in terms of sustainable indicators. Section 4 recalls the modelling system developed by authors for ex-ante assessment of city logistics measures and gives some empirical results obtained by the validation that can be taken into account in a city logistics plan. Finally, some conclusions are given in section 5.

2. URBAN FREIGHT TRANSPORT: MOVEMENTS AND ACTORS

City Logistics is defined 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 within the framework of a market economy." (Taniguchi *et al.*, 1999, 2001). Some authors extend this definition in order to consider all involved actors that, in general, are in competition among them. Thus, before to proceed to the analysis of urban freight transport and logistics, it is useful to identify which are the goods movements interesting urban area and who are the actors/decision-makers.

During the last miles (generally within the urban area), the freight can be moved directly by end-consumer (private or business end-consumer) who purchases and consumes it and travels from her/his residence/consumption zone to others where she/he makes the purchases (*end-consumer movement*), or by several logistic operators that allow shops and warehouses to be restocked (*logistic movement*).

Referring to movements from producer to end-consumer, it is possible to identify three main functional relations that allow freight to reach end-consumer:

- the customer buys directly by producer without moving from her/his residential/consumption zone (e.g. on the web, by phone) and the producer sends the products directly from the production site to her/his consumption site (directly - without any contact points);
- the producer uses a network of retailers in order to reach the consumption zone (one contact point – retailer);
- the producer uses some logistic point in order to reduce logistic and transportation costs (one or more contact points to consolidate and/or deconsolidate the load).

After having identified which are the goods movements that interest urban area, an essential feature of the success of any such (sustainability enhancing) plan is to consider the role and the needs of the different actors involved and their acceptance of the policy scenarios envisioned (DfT, 2003). In particular, active consultation between stakeholders is crucial to define a more coherent and realistic city logistics policy mix. It is important to recognize and adequately understand the concerns of different stakeholders and their problem identification with respect to urban freight transportation in order to successfully introduce city logistic measures.

The urban freight transport may be analyzed in more detail from the point of view of each agent type. The main actors involved in the process can be aggregated in the following three classes (Ruesch and Glucker, 2001; Russo and Comi, 2010a):

- end-consumer actors (inhabitant, whose main interest is minimum hindrance caused by goods transport, and visitor/shopping public whose main concern is minimum hindrance caused by goods transport, variety of the latest products in the shops and low price of products),
- logistic actors (e.g. shipper/wholesaler, whose main interest is delivery and pick-up of goods at the lowest cost while meeting customer needs; transport company, whose main interest is a low-cost but high-quality transport operation, satisfying the interests of the shipper and receiver/shop; receiver/shop owner, whose main interest concerns products delivered at a short lead-time);
- public administration actors (e.g. local government, whose prime concern is an attractive city for inhabitants and visitors; national government, whose main interest is to minimize external effects from transport and maximise net economic benefits).

3. CITY LOGISTICS MEASURES

A review of the various measures implemented and their results have been carried out by COST 321 (1998), City Ports (2005) and BESTUFS (2007), even if the proposed classifications are mainly descriptive and are not useful for modeling implementation in the sense of the ex-ante assessment. A possible classification of measures can consider the following four classes:

- measures related to *material infrastructure*;
- measures related to *immaterial infrastructure* in which it is possible to consider consolidated ones (i.e. human capital, research, learning/training) and also telematics or Intelligent Transportation System;
- measures related to *equipment*;
- measures related to *governance* of the traffic network.

Implementation of one or a set of measures can be considered a rational decision-making process and can have different temporal scales: strategic, tactical and operative. Strategic horizons involve decisions on long-term capital investment programs for the realization of new infrastructure (e.g. urban distribution centers, roads) and/or the change of vehicles and technologies (e.g. environment-friendly vehicles and control systems). 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). Short-term operative programs can include the implementation of some measures that regard particular aspects of mode operations (e.g. time windows).
Importantly, the implementation of measures is driven by the willing to obtain some strategic objectives (goals) on short, medium or long-term. These objectives (goals) can be defined in terms of outcomes regarding efficiency, safety and air pollution. Thus, city logistics measures can be classified in terms of objectives to be obtained.

3.1 Material infrastructure measures

The main objective of this type of measures is to increase sustainability within the urban area by implementing action to optimise freight transport. Material infrastructure measures can be classified

- linear, if they refer to links of the urban/metropolitan transport network (e.g. use of an urban transportation sub-network only for freight vehicles);
- surface (and/or nodal), if they refer to areas that can be reserved for freight operations (e.g. areas for loading and unloading operations, logistic nodes to optimize freight distribution in metropolitan/urban areas like Urban Distribution Centres);

Linear measures refer to urban transportation network links, hence definition of an urban transportation *sub-network only for freight vehicles*. This sub-network measure mainly refers to transport companies and local government. This measure is a long-term policy (strategic/tactical) and could require the provision of new and specific infrastructures. The main obtainable effects refer to efficiency. In some European cities (Schwarzmann, 2009), implementation of sub-network only for freight vehicles has given an increase of efficiency with a reduction of both travel time (-0.8%) and trip length (-2.7%).

Example of surface measures are *loading and unloading zones*, which have provided good solutions for many dense urban areas. This allows a decrease in on-street parking, hence the influence between commercial and private transport. Such a measure affects transport companies, receivers and end-consumers (residents and visitors) and local government. If we consider the realization (construction) of new organized loading and unloading zones, it can be considered a middle-term (strategic/tactical) measure. From some ex-post assessment (Marciani and Cossu, 2001) it emerged that it possible to obtain by its implementation a stop time reduction for doing loading and unloading operations of 18% (efficiency).

Rationalization of freight flows by installing a logistics platform, usually called an *Urban Distribution/Consolidation Centre* (UDC), has attracted great interest. The Urban Distribution Centre is a place for transshipment from long-distance to short-distance (urban) traffic where consignments can be sorted and bundled. This type of measure meets the interests of shippers and transport companies (potential users). This type of measures must be considered in the strategic master plan of city and it needs an in-depth analysis in order to evaluate the benefits and the added costs borne by freight actors for transshipment operations. The implementation of UDC can determine: economic, social and environmental effects. For example, UDC could bring to a increasing of travel time (efficiency) estimable in about 20-30%, and also reduction of external cost related to safety and environmental (Stefan, 2008). Such centers could help re-balance the modal split and reduce environmental impact.

In France, following the idea of UDC the *nearby delivery areas* (Espace de livraison de proximité - ELP) have been implemented. The ELP are urban transhipment platforms on which dedicated staff provide assistance for the dispatching of consignments for the last mile (inner city). Goods are unloaded from incoming vehicles, and can be loaded onto trolleys, carts, electric vehicles and bicycles for the final distribution leg. This measure involves receivers, shippers, transport companies and end-consumers. It can be considered a tactical measure and may have economic and environmental impacts (reduction of time per stops, reduction of pollutants).

3.2 Immaterial infrastructure measures

In this paper, within the class of immaterial infrastructure we consider only measures related to Intelligent Transportation System (ITS). They 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 efficiency and broadening the scope of enforcement.
This class includes systems for traffic information, freight capacity exchange systems, route optimization services, vehicle maintenance management systems, other information services through internet access, and centralized route planning.
Telematic applications for electronic *access control* or *traffic monitoring* and *traffic control* have been applied in several cities (e.g. Maribor, Brno, Salzburg and Rome). These measures concern transport companies and shippers as well as public administrators. The policy seeks to reduce economic (e.g. in terms of traffic congestion) and environmental (e.g., air pollution) impacts.
Telematic solutions applied to support vehicle routing and scheduling systems can result in journey time savings of 10 to 15% (Taniguchi *et al.*, 2001).

3.3 Equipment measures

The equipment class includes measures:

- on loading units, if they refer to the introduction of new standards for loading units to optimize handling and transport by new low-emission vehicles;
- on transport units, if they refer to characteristics of transport units (e.g., reduction in truck emissions and use of electric vehicles, methane vehicles, metropolitan railways, trams).

Such measures chiefly concern producers that, driven by the implementation of sustainability measures in urban and metropolitan areas, build new *low-emission vehicles* equipped with devices to facilitate handling and increase safety, efficiency (e.g. fuel consumption), noise and air pollution. This type of policy can be implemented, and may improve the sustainability of each city, independently of governance measures. These measures affect shippers and transport companies since they could modify their transport organization and fleet. Such measures require high investments and may be considered a long-term policy (strategic).

As regards vehicles, we find many vehicle restrictions around the world according to their physical characteristics: *weight*, *space occupancy* and *emissions*. These measures seek to change the types of vehicles driving in inner cities, hence the vehicles used by transport companies. Their impacts are mainly on shippers, transport companies because they must be equipped with appropriate vehicles and on end-consumers (residents and visitors in the urban area). The objective of such measures is to reduce traffic congestion (weight and space) increasing efficiency and air pollution (emissions). For example, the incentives promoted to use less polluting vehicles or even to renew the vehicle fleet; this measure can be based on propulsion, on emission class or on vehicle age.

3.4 Governance measures

In the class of governance measures we find traffic regulations (e.g. access time, heavy vehicle network, road-pricing, maximum parking time, maximum occupied surface and specific permission).

Many cities have regulations on delivery *time windows* within city centres and especially for pedestrian zones. These measures can be considered short-term policies (tactical/operative), and while such measures are easier to implement, they require a sound surveillance system to prevent any possible violation. Such measures can influence the decisions of recipients (retailers) who might at times change shop opening times, and shippers and transport companies that must organize their activity in compliance with this regulation. Their implementations have given good results in terms of economic and environmental sustainability. For example, some ex-post assessment have revealed a reduction of trip length (-16%), travel time (-28%) – efficiency – and reduction of particles (-15/-20%), hydrocarbon (-5/-20%) and nitric oxides (-1/-8%) – environmental (Schoemaker, 2006; Russo and Comi, 2010a).

Other governance policies concern the requirement of a *minimum load factor*. This type of measure applies to transport companies and can be considered by the city planner as a short-term policy (tactical). Here the aim is to create incentives to increase the load factor, which is beneficial in terms of efficiency and, thus, in terms of reduction of operating vehicles and pollutant emissions.

Some city administrators, in the tactical plans, have recently tried to create incentives to *switch from own account to third parties*. The presumption here is that third account is more efficient. The problem of empty running in one leg of the delivery trip (return leg) and of the collection trip (outward leg) occurs in own account operations and is indicative of poor efficiency. Another reason is the occupation of parking space by own account vehicles which is seen negatively when, during idling periods, the vehicles are parked for many hours in areas with a shortage of parking spaces.

In order to achieve environmental sustainability, the local authorities must control the measurement of ambient air-pollution concentrations in order to determine whether there is a problem in the city. Local authority powers to control sources and levels of air pollution will often be dictated by international and national policy and laws. Often, local authorities can also influence local air quality by introducing *traffic limits* in specific areas. This type of measure can be considered an operative measure and mainly concerns transport companies.

A governance measure is also *road-pricing*. Different forms of access charging have been implemented in many cities. This measure affects shippers, transport companies, receivers and end-consumers since its implementation could influence the cost of transport and hence the costs of products (economic impacts). It could also modify the revenue of some of the actors (e.g. transport companies). In some European context it has been revealed a speed increasing of 15% with reduction of operating vehicle and increasing of low emission vehicles (+62%; Comi *et al.*, 2008).

Specific permissions are, for example, related to permissions to use linear or surface infrastructures. For example, we can find permission to use bus lanes as permitted to other types of vehicles such as taxis, diplomatic cars and cars used by the disabled. Thereby, a sub-network for freight vehicles is developed (see also material infrastructure measures and similar effects can be obtained for the reduction of operating vehicles in terms of safety). It can be considered a tactical measure. Transport companies would benefit from the reduction in travel time and hence increase the efficiency of their activities (economic impacts).

Finally, an other specific permission is that for using *loading and unloading zones*. The aim is similar to that discussed in the case of material infrastructure measures with the difference that the areas are subject to specific permits. Such measures are easy to apply and can be considered a short-term policy (operative) to reduce the influence of freight transport on the city mobility (environmental impacts). As said, this type of measure can decrease loading/unloading time and, thus, it can reduce the operating vehicles.

4. EMPIRICAL RESULTS AND INDICATIONS

The effects of city logistics measures described in the previous section are based on *ex-post* assessment, but they can be obtained using urban freight modeling system. In the following some indications based on the results obtained by the implementation of the modeling system developed by the authors (Russo and Comi, 2010b) are given.

The proposed modelling system is developed on two levels and concerns a medium-size city, applying a disaggregated approach for each decisional level (Figure 1):

- *commodity* level (first level) concerning estimation of quantity Origin-Destination flows; at this level the models concern calculation of OD flows related to consumption, and OD freight flows related to restocking;
- *vehicle* level (second level) that allows quantity flows to be converted to vehicle flows; at this level the models concern determination of the service, vehicle and time used as well as the path chosen for restocking sales outlets.

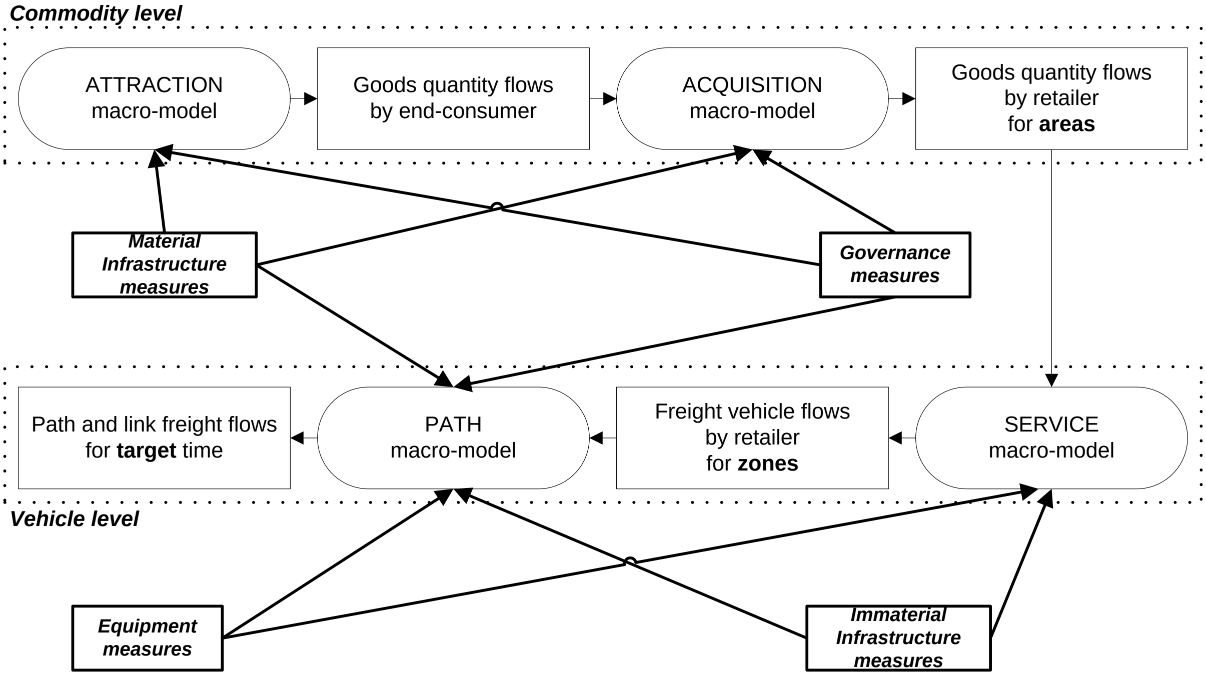

Figure 1 - Modeling system structure

The proposed modelling system was calibrated using two different types of surveys: one targeting end-consumers, the other retailers. The end-consumer surveys were carried out for durable and non-durable goods in Giarre, a southern Italian town with about 30,000 inhabitants and about 700 retailers, during four different working days, from 9.00 a.m. to 8.00 p.m. About 450 customers (private end-consumers) aggregated in 200 groups were interviewed (usually a shopping trip is undertaken by a set of people that will be termed group below). This survey provided information on the goods consumed by end-consumers, purchase trips and size of purchases. Daily and non-daily freight consumption was also studied. The questionnaires were structured in order to identify the socio-economic characteristics of interviewed households (e.g. residence, composition, gender) and characteristics of purchase trips (e.g. round trip or trip chain, purchase zone, freight types, time spent in a shop before purchase, dimension of purchase).
The retail survey consisted of more than 1,000 interviews of retailers carried out in the city of Reggio Calabria (southern Italy) with a population of more than 180,000 and in the city of Palermo (southern Italy) with more than 800,000 inhabitants. The focus was both on retail shops and on supermarkets. The interviews allow us to discern some characteristics that determine how and from which zone the restocking is done by retailer (e.g. acquisition zone, used vehicle and target time). The interviews were carried out to obtain some general information on the retailer and shop, such as shop location, shop size, main types of goods sold, number of employees, average number of customers per day and week, and storage availability.

In the following some useful addressing obtained by the implementation of the recalled modelling system is given. The analysis is done in terms of involved decision-makers and their impacted choice dimension.

4.1 Commodity level

The commodity level consists of two macro-models: *attraction* and *acquisition*. The *attraction* macro-model refers to end-consumer quantities, and it has general socio-economic data (residents, number of employees) as input and gives as output the goods quantity required by them (goods quantity flows by family).

This attraction macro-model allows to analyse the freight quantity required by end-consumers. In fact, the estimation of freight quantity flow attracted by each traffic zone is assumed as generated by the consumption of goods, as part of the conduct of a given, generic urban activity undertaken by consumers. The models have been calibrated for two type of weekly trips for purchases: durable and non-durable goods. This classification was used because it gives the best results in Italy, in simulating end-consumer trips at an urban scale.
The models within the attraction macro-model allow to obtain the OD flows in terms of passenger trips for purchases and after convert these OD flows into freight quantity OD flows by a dimension choice model. For this aim, a logit model was developed in which three different alternatives are defined: no purchases (dim_0), purchases with a dimension less than 10 dm^3 (dim_1) and purchases with a dimension more than 10 dm^3 (dim_2). The possible difficulty in applying the model thus specified and calibrated can be solved using the pivoting method. Calibration results have confirmed that many people travel for shopping together or for recreation (no purchase) or to buy many things (dim_2). It is also emerged that the probability of making a large purchase increases with the time spent inside the shop, the size of the group and if the customer is male and goes in alone. In particular, from in-depth analysis of the results, it is worth noting that time spent in a shop affects the size of purchase. The same, with opposite sign, occurs if the end-consumer is older than 35. Note the effect of cardinality: increasing the group size raises the probability of making a large purchase or no purchase at all. This macro-model allows us to investigate how some urban policies (material infrastructure and governance) modifying the generalised travel costs for passenger or the sale network can modify the end-consumer behaviour in the choice of the retailer area (e.g. road-pricing) and, thus, attracted goods quantity.

The *acquisition* macro-model concerns logistics trips from the retailer's standpoint; it allows us to investigate by which type of distribution channel and from which macro-area (inside or outside the study area) the freight arrives to attraction zone. This model receives as input the goods quantity required in each traffic zone by the retailer and, in analysing the restocking process, it gives the quantity that is acquired inside or outside the study area (goods quantity flows retailer for areas).
The model system has been characterised for the case in which the restocking is done directly by retailer (c_r). Thus, the probability retailer does the restocking is evaluated by a binomial logit model. This choice is simulated assuming that the decision maker is the retailer (shop owner) and this probability is obtained by a binomial logit model. The obtained results evidence that on increasing the restocking quantity per trip and the restocking frequency, the

probability of not having as decision-maker the retailer (c_l) increases. In particular, we may dwell on the importance of travel time in the choice: the absolute value of parameter relative to travel time for c_l is higher than c_r, as proved by the propensity for third parties to optimize their trip better than retailers. The results demonstrate that increasing the travel time and the introduction of more restrictive time windows (governance measures) could lead to an increase in c_r and hence freight transport that is no longer efficient.
After the analysis has been carried out in order to obtain if the retailer bring the freight sold in her/his shop inside or outside the study area A binomial logit model has been also used to determine the probability of choosing to restock inside or outside the study area with reference to c_r. The results have confirmed that retailers prefer to restock from neighbouring warehouses in order to make more than one trip per day. Indeed, many of the city-centre shops have little space to store unsold products. This could increase the number of freight trips and could have negative effects in terms of city sustainability. The inclination to use a distribution centre (or similar structure – nodal material infrastructures) close to the city centre is shown. This step also allows to evaluate the impacts due to the implementation of governance measures, such as incentives to switch from own account to third parties and so on.

4.2 Vehicle level

The vehicle level consists of two macro-models: *service* and *path*. The *service*-macro model receives as input the demand in quantity for a macro-area and gives as output quantity for each consignment, zone and vehicles needed for restocking. At this stage the analysis consists of two main steps: estimation of number of stops per trip chain, and size and stock zone. In particular, as demonstrated by some surveys carried out in some Italian cities the retailer makes only one trip chain in a day with a number of stops equal to 1 in 90% of cases, we have assumed that each retailer brings in a zone all freight she/he need, and this quantity is equal to the load capacity of her/his vehicle. In other words, the analysis of shipment size (parcel) is done in term of holding vehicle. The choice of stock zone is simulated by a logit model in which the utility of each alternative (stock zone) is a function of three different classes of attributes: attributes specific to the generic stock zone, attributes specific to the freight type and attributes of generalised cost that regard the disutility of bringing freight, sold in shops. These results confirm that warehouse areas located close to the city with good accessibility (in terms of travel time) yet separate from retail areas (shopping areas) is preferred for doing restocking. The vehicle holding model was specified and calibrated as a logit model with two alternatives: vehicles that have a loading capacity less than 10 m^3 and others. From the first results, it emerges that the probability of using light goods vehicles decreases, as expected, with depot size and travel time distance, and increases with restocking frequency as justified by just-in-time. The results confirm the tendency to use light vehicles for small shops with few employees and a small depot. This type of retailer prefers to use light vehicles to undertake more than trip per day and bring only freight that is sure to sell in the near future. This result shows the inclination to accept measures related to equipment, such as incentives to change one's own vehicle to a new lighter one. This step allows to take into account the variation of Level of Service attributes (e.g. travel time and cost) due to the implementation of material city logistics measures, such as Urban Distribution Centres, or governance measures (e.g. time windows, road-pricing, parking restrictions). The implementation of ITS measures could influence the origin choice, because, for example, traffic information systems and systems for route optimization are related to the expected generalized travel cost. This step also allows also to take into account how equipment measures can influence the composition of truck loads, such as restriction on vehicle type access (e.g. gross laden weight more than a given value). The vehicle holding model allows to assess impacts due to the implementation of some governance measures related to the equipment in the field of urban freight transport, such as access restrictions to some classes of vehicles subject to environmental standards or laden weight.

Finally, referring to the *path* macro-model, our attention is on time and path models. In fact, the macro-model receives as input the demand in vehicles and gives as output the departure/arrival time and path used; it can be both static and dynamic. In many cities around the world and as confirmed by our test cases, time is constrained by governance regulations: the public authorities define one or two time windows (e.g. one in the morning between 8:00 – 10:00 a.m. and one in the afternoon). As regards the path model, under the assumptions introduced in this study (round trip), in the literature we find many studies developed for ring (one-to-one) trips. Such models are used both for congested networks within equilibrium or dynamic models and for non-congested networks within static or pseudo-dynamic network loading models. It be note that the path model allows us to consider how all types of measures can influence the choice of path used for restocking tour (e.g. specific road, road-pricing, traffic information system, emission or weight limits).

5. CONCLUSIONS

Congestion in urban areas, restrictions applied to vehicle movement for sustainability issues, as well as the reduction of accessibility of particular urban centers, have been forwarded researchers to investigate solutions to define city logistics measures to reduce the negative effects of freight transport. For this reason it is important to have useful starting tools that allow to identify the main results obtainable from the implementation of city logistics measures. At this aim, the paper proposes a framework that can be a useful starting tool for city authorities when designing measures, which ideally should be done in co-operation with freight operators, and needing to verify whether their expected results match the results obtained in the other cities. The paper also resumes the main results obtained by the validation of an integrated modelling system developed by authors for simulating urban freight transport and logistics. The modelling system has been specified and calibrated on the basis of a real test cases (cities and towns in the southern Italy). Models have been specified in order to create an integration with passenger trips. In fact, the literature few freight models explicitly represent the interplay between movements of goods and movements of passengers (for example, Freturb model by Routhier and Toilier, 2007). This interaction is especially relevant in the urban context where congestion is an effect shared and generated by both markets and presumably the decision makers take that effect into consideration before making a transport decision.

Finally, we can conclude that analysis and selection of implementable measures has to consider such actors and find an optimal compromise between all interests of the actors involved. In fact, deciding on implementation measures requires full assessment of social costs and who has to abide by them The dominant pattern currently found in cities is one where prohibitions are the rule. While some of the measures outlined in the paper are those promoted and implemented by public authorities, other categories are either promoted directly by private agents (especially as regards management measures) or are the result of an incentive from public authorities to private agents.

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