Bestufs WP3 Rome roundtable - Issues Part 2:

URBAN FREIGHT POLICY-ORIENTED MODELLING

INTRODUCTION

A lot of approaches have been developed help decision making in the field of City Logistics. Those are essentially developed with the aim to improve the efficiency of the transport system (Yamada and Taniguchi, 2006). A lot of models are mainly Conceptual Models (CM) and it is often difficult to fit them into a practical situation. The aim of this summary is to focus on the Policy-Oriented Modelling (POM), i.e. data-adjusted model, oriented towards policy analysis (as defined by Scott *et al.*, 2005). The aim of the models described here is to explicitly simulate freight distribution within the urban areas for evaluation, control and design of urban freight transport system.

METHODOLOGY

Levels to calculate Urban Goods Movement (UGM)

Four levels of UGM calculations or methods are generally used in urban praxis (table 1). The levels range from flat-rate addition to the individual traffic, calculation based on traffic counts, surveys in city areas with traffic problems, to model calculations of complete O/D matrices. According to the aims of the BESTUFS project only policy-oriented models (POM) in use should be included in the European survey.

Table 1

Method	Advantages	Disadvantages
Flat-rate addition to the values of individual traffic	Cheap, quick	Very rough
Calculations based on traffic counts, e.g. inner city road crossings	Good for evaluation of hotspots	Personnel intensive, no information about behaviour and O/Ds
Surveys in city areas with traffic problems	Measure-oriented approach (e.g. traffic regulation, technical measures)	Only suitable for small areas
Model calculations	Complete O/D matrices, policy-oriented models (POM)	Need a lot of data

According to many authors, the model calculation approaches of UGM can be divided in the following classes:

- the scale: international, interurban and urban,
- the main unit to estimate: in the commodity-based models aim to calculate the movement of goods, in the truck-based models, the movement of vehicles is directly modelled.

Beside this, also the differentiation of input and output of the models is a suitable characterisation to divide the model approaches.

Before the European survey of UGM models was carried out, BESTUFS experts identified numerous reasons for the failing of urban goods modelling:

- There is a lack of data because it is difficult to capture the complexity of the logistic chains. Most tours are pick up and delivery tours (trip chain pattern).
- There is also a large diversity of behaviour of the industrial branches concerning the generation of traffic and their trip chain pattern.

- Urban modelling is usually focused on the O/D approach. The current four step passenger models enforce a framework inappropriate to describe the rounds.

EUROPEAN REVIEW

Most of the modelling approaches have been developed in Germany, Italy, France and the Netherlands. The case of the Netherlands is described in the Visser (2007) paper. Therefore it is not taken into account here.

In **Germany** the first approach to calculate UGM on the basis of an O/D model for a complete region with 300 zones was made by Sonntag (1985). The development was fostered by the raised awareness of cities regarding the high share of commercial and goods transport both in the complete urban transportation scheme and in the pollutants generation. The model called WIVER model has been developed to produce O/D matrices for the road based UGM and other commercial related activities.

WIVER is a behaviour-oriented simulation model, which is able to consider explicitly the complexity of urban trip chain pattern. Therefore, the model can focus on four types of vehicle classes: commercially used cars, vans/transporters ≤ 2.8 tons, trucks > 2.8 tons and trucks > 7.5 tons. To mirror the different behaviour of logistic activities in different economic sectors (branches) the model is able to compute traffic values for 10 branches separately. The WIVER model is steered by behavioural data, which show considerable differentiation between branches and types of vehicles, and statistical data:

Behavioural Data (per branch)
- number of tours and destination distribution per vehicle type and day,
- purpose of trips,
- distance and structural parameters for modelling source-destination interactions,
- degree of efficiency of tours per branch and vehicle type ("level of savings"),
- distribution of trips over time.

Structural Data (per zone)
- distances in the area to be investigated to other zones,
- calculation of the potential of each zone as a source (data: number of employees and number of traffic related employees per branch),
- calculation of the potential of each zone as a destination.

WIVER is suited to model urban freight traffic or urban goods movements, providing information regarding total mileage, number of trips, number of tours, traffic distribution over time (day course), subdivided into vehicle type and branches (economic sectors). Furthermore, source/destination relations and transport- or trip chains can be modelled. Fields of applications can be: detailed analyses and support of planning steps in a specific city or region like truck guidance networks, action plans regarding commercial transport as well as calculation basis for the pre-test of traffic organisation and fiscal measures.

WIVER was applied in the following German and European traffic planning processes:
- Hamburg 1993,
- Berlin 1994 (Sonntag et al., 1995),
- Within the framework of the European project COST 321 - URBAN GOODS TRANSPORT for the cities Munich ,Nuremberg, Augsburg, Hanover and Trier 1995 – 1997 (COST, 1998),
- Within the framework of the European project REFORM - Research on Freight Platforms for the regions Rome and Province Latium, Madrid and Brussels Capital Region 1997 (REFORM, 1998),
- Berlin 1998: Investigation of the effects of logistic nodes (Meimbresse et al., 1998),
- Hansestadt Rostock 1999 and Berlin 2000 (evaluation of a truck guidance system).

Using the main approach of WIVER, Lohse (2004) developed a model called VISEVA - W to compute simultaneously and interdependently the traffic volumes of different branches and vehicle types. The model starts with rates for mobility, modal split and affinity to vehicle classes/transport modes (behavioural data) as well as spatial data of the involved traffic zones, networks and conditions. After the generation of O/D relations the trip generation is calculated on the basis of a series of interdependent equilibrium formulas. By this, the model avoids the complex process of calibrating the savings functions used in WIVER.

In **Italy**, **Russo and Carteni** (2006) propose a regional modelling procedure based on the simulation of the dependence existing between successive trips of the same distribution channel. They make the distinction between trip-based and tour-based modelling. In the first case, the choice for each trip between two transhipments is independent of the choice carried out for other possible trips belonging to the same journey. In the second case, the choice for each trip affects the other trips belonging to the same journey. The authors have a preference for the tour-based modelling approach. In order to match with the various types of origin, transit and final destinations, five commodity classes are defined (Foodstuff and agriculture products, Energy products, Minerals and metals, Chemical and pharmaceutical products, other). Commodity types (perishable, non perishable, high/low value, volume, hazardous/non hazardous), company classes (large-medium-small) and manufacturing process (just in time/in stock) are defined.

In order to integrate the consumer behaviour in the supply chain, **Russo and Comi** (2004) propose a simultaneous analysis of the end-consumer movements between the shops zone (*d)* and the consumption zone (*o*) on the one hand, and the movement between retailer and warehouses (*w)* (re-stocking) on the other hand. This approach might be useful to analyse freight mobility in a global planning process in two parts. The first one may be carried out by a round trip or a trip chain. The second one may be performed through a supply chain or tour-based approach (see above). The authors propose a model structure divided in an attraction model (demand in freight quantity for each *o-d* (end-consumer) and an acquisition model (demand in freight quantity for each *d-w* (logistics). The latter is composed of a channel choice model (probability to choose a channel to bring freight for restocking in zone *d* and a stock model (probability that a retailer take the freight sold in his shop, arriving from the zone *w*). This approach is promising because the link between passenger and freight models is made. Nevertheless, it seems that the results of such a modelling approach have not yet been available.

In the City Goods modelling framework**, Gentile and Vigo** (2006) develop a prototype demand model which is in test on several cities of Emilia-Romagna. According to the authors, two problems must be solved:

- a given activity (a fortiori a given zone) generates movements belonging to different supply chains,
- a vehicle performs many deliveries or pick-ups in a tour.

The objective is to build a demand generation model in order to estimate the yearly number of operations generated by each zone.

In **France** the urban freight model FRETURB has been developed by the LET, (Routhier et al., 1999, 2007). It is a land use and tour-based model of urban goods transport. It consists of three modules which interact with each other: - a "pick-up and delivery model" including commodity flows between all the economic activities of a town; - a "town management module", consisting of transport of goods and raw material for public and building works, urban networks (sewers, water, phone), and removals; - a "purchasing trips model", modelling shopping trips by car, which represents the main last kilometre trips to consumers.

The pick-up and delivery model is a regression-based model fed by thorough coupled 4,500 establishments and 2,200 drivers surveys carried out in three different sized towns. Those surveys brought to light relevant relationships between the behaviour of the shippers (spatial and economic data) and the behaviour of the hauliers (operations of transport). The modelled data is the movement of goods (defined as a delivery or a pick-up associated to a given establishment, vehicle size, mode of management and logistic behaviour). It is derived from the empirical survey data resulting from statistical validation.

Since 1995 the model has been increasingly improved. It has been available as software since 2000. It is implemented in about 20 French towns (among which Paris, Lyon, Lille, etc.). The FRETURB model is using widely accurate rules and laws on logistical behaviour of the different stakeholders of urban goods movement proved by appropriate surveys. It works with numerous and homogeneous industry categories permitting a thorough description of the urban logistics in a French town. It requires a local establishment database but no large local surveys.

IN OTHER COUNTRIES

A few reasons contribute to explain why the development directions in **the USA** are not the same as in the EU in the field of urban freight modelling (Ambrosini *et al.*, 2007). The usual scale of modelling is rather the regional or even the state level because the urban spatial constraints are looser than in old historic European cities. Moreover, current practices are always using old standard models, which are not adapted to the new emergent issues. The latter require a better knowledge of the behaviour and of the share of all urban stakeholders. City planners still continue to base their urban freight models on commodity flows. This approach seems irrelevant when used without a thorough knowledge of the urban logistic behaviour of the stakeholders because goods flows represent the real demand, whereas the vehicle-trips ensue from urban independent (much more than at the interurban scale) logistical decisions.

In recent years, a number of **Japanese studies** have been published dealing with urban freight modelling. Among the most typical ones, we would give here the general outlines of the approach developed in Taniguchi *et al.* (2001) and Yamada and Taniguchi (2006). It is about a simulation model, based on the vehicle routing and scheduling problem with time windows to investigate and to compare the effects on freight traffic flows from several urban freight transport schemes. The most recent investigations bring into play new solutions, notably co-operative freight transport systems, advance vehicle routing and scheduling systems, access restrictions of delivery vehicles to the city centres, and road pricing.

The modelling framework consists of two levels (behaviour of administrators and behaviour of freight carriers). Co-operative freight organisation is introduced into the second level. Each freight carrier tries to minimise his total costs, while the co-operative freight organisation and the public sector try to minimise their total travel time. Mathematical programming problems being complex, genetic algorithms are implemented to get significant solutions.

In order to overcome the complexity of the relationships between the freight agents, Wisetjindawat *et al*. (2006) proposes a microscopic modelling approach considering the individual behaviour of each freight agent and its interaction with the other freight agents in the supply chain.

CONCLUSION

The analysis makes clear that two main distinct approaches are developed: the first one is based on the optimisation of the logistic process, including the total supply chain channel, usually by means of Operational Research (OR) procedures. Several objective functions are implemented and calibrated on macro-economic data and traffic flows data.

The second approach is based on a thorough analysis of the behaviour of the local units (or establishments) by means of Statistical and Probabilistic (SP) adjustment methods, through profound surveys on establishments and carriers to have an accurate disaggregation according to the industry and the size of the establishments. Moreover, in this case, it is not necessary to convert the commodity flows in vehicle flows.

The first OR approach is as said in Taniguchi *et al.* (2006): "It is essential to forecast the commodity flows and freight transport activities for identifying the pattern of logistics activities and understanding the issues of urban freight transport", while the SP approach firstly describes the behaviour of logistic generators in order to explain the traffic flow generation.

In France, data collection and modelling approach are simultaneously designed at national level because of a centralised custom, because there are large registers (SIRENE) of establishments and because the funding of large surveys is possible due to a State will. But that's not the case in most of other European countries. However in the recent years, an increasing harmonisation as regards the words, the concepts and the methods used can be noted; hence, data collection and modelling tend to come closer, at least at the European level.

Furthermore, apart from the operational short term assignment models (e.g. TLUMIP, in the USA), the only applied policy-oriented models (i.e. published software for local authorities) are based on well fitted collected data (VISEVA-W and FRETURB). Other models, like Italian models, are, for the time being, essentially experimental.

However, it is urgent to tackle the current stakes related to a sustainable development. In this way, the knowledge field regarding the features of the flows must be enlarged. These features exceed greatly infrastructure and speed constraints, and have to include basically the spatial components (density and urban patterns), just as the global logistics changes (just-in-time, decrease in stocking, ITS, last mile optimisation), in the context of the globalisation of the economic activity.

Moreover, current urban data collections focus at most on land use and transport indicators with insufficient description of goods management. For that reason it is difficult to explain why the flows are as they are, so that the power of prediction of current models is not very efficient.

There is always an imperative need to integrate goods transport in a systemic approach towards urban logistics as a whole. Indeed, on the one hand goods transport is subject to competition due to consignor pressure and globalisation, and on the other hand distribution conditions worsen because of an increasing traffic congestion leading to negative environmental impacts.

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