



Modelling goods city distribution in the Netherlands

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Abstract

The interest in data collection and modeling of urban freight transport is rising. This paper describes a recently developed method for data collection, analysis and modeling that has been applied in several Dutch cities. By treating urban freight transport in an integral way, important relations between transport demand, traffic, economic-, social- and environmental variables are uncovered. The paper is interesting for local policy-makers and researchers in the field, by improving their understanding about urban freight transport and its specific research requirements.

Keywords: Urban freight transport; Data collection; Modelling; The Netherlands.

Introduction

Urban freight transport is “the delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flow of used goods in terms of clean waste” (OECD, 2003). Optimization of urban freight transport is a key issue in city logistics. City logistics has been defined as (Taniguchi et al., 2004, p. 1) “the process of 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”.

For delivery and pick-up in urban areas either trucks, vans or passenger cars are used. In rare cases small vessels or trains are used. In most cities, there is hardly any local manufacturing or warehousing of goods, which means that freight has to be transported over considerable distances.

Urban freight transport contributes to the economic functioning of a city. It also creates externalities, like congestion, noise and hazardous situations. These problems

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and issues and the multitude of actors, users and non-users with their different opinions and interests make urban freight movement “enormously complex and heterogeneous” (Ogden, 1992). This leads to the following questions:

- What problems are caused or engrained by urban freight transport?
- Why do these problems continue?
- Who could or should solve or reduce these problems and under what conditions?
- Which options are likely to work?
- What are the costs and benefits of solving the problems?

These are very relevant questions, because in many cities there is a controversy about the impact of urban freight transport on the city between key actors like public policy makers, transport operators, receivers and citizens. This controversy has many causes. Apart from miscommunication between the parties involved, there are diverging interests and, a problem that is the theme of this paper, the lack of empirical information about urban freight transport. It may be assumed that the definition and solution of (perceived) problems can be carried out more efficiently with data of sufficient quality. By addressing the importance of data, the role of research into urban freight transport comes at the agenda. In general, three research approaches can be distinguished:

- policy-oriented/qualitative research;
- empirical research;
- modeling/simulation-oriented research.

This paper is about the second and last approach. It elaborates the results of a Dutch empirical study (TLN et al., 2003a), aiming at developing the method to collect, process and analyze data about goods delivery in selected Dutch cities. Part of this approach was to develop an analytical model, which could be used for quantitative analysis of the collected data.

The empirical study is one of the more recent initiatives in this area, initiated inter alia by OECD and EU. Both organizations stimulate practical applications in member countries. By considering best practices, member countries gain ideas about improving urban freight transport. The Bestuufs thematic network fits in this scheme. It has been set up to develop “European-wide approaches to common problems and issues surrounding urban freight transport within metropolitan cities in the European Community.” (Mortimer et al., 2004, p. 4). In the Netherlands, the Forum for Physical Distribution in Urban Areas (PSD) fulfills a similar role. The PSD initiated the background study, together with the Dutch organization of freight transport suppliers (TLN), and local governments of Amsterdam, Rotterdam and Utrecht. Connekt B.V., a so-called knowledge transfer organization and these local governments commissioned the background study.

The structure of the paper is as follows. In section 2 urban freight transport and its main problems are discussed. Section 3 deals with methodological issues encountered during the development of a methodology to support decision makers in urban goods transport. In section 4 an application of the methodology is presented. In section 5 main lessons about past research are presented. Finally section 6 ends the paper with conclusions and recommendations for future research.

Systems and problems

Introduction

Cities are concentrations of interacting human activities. In historic inner cities the road network is usually not compatible with the demands of modern (freight) transport, but also in other parts of a city problems may exist due to other reasons. During driving, parking and (un)loading, urban freight transport vehicles compete for space with private cars, pedestrians and bikers. Gridlocks occur, causing delays and increased air pollution. Government regulation with respect to vehicle dimensions and weight, and delivery time windows increase the logistic requirements, which are already considerable. Table 1 provides an overview of logistics requirements and their implications in cities.

Table 1: Logistics requirements and their implications.

<i>Logistics requirements</i>	<i>Implications for the city and urban freight transport</i>
Chain reversal (order-driven instead of supply-oriented logistics) and efficient customer response (ECR), moving stocks upstream the distribution chain High order frequency, small drop sizes	Short lead times More deliveries for the same transport volume, higher distribution costs
Delivery before staff arrives Just-in-time delivery	Delivery is later than optimal for driver Minimal stocks, delivery certainty is more important than higher transport costs
Restrictions on vehicle size, axle weight Many receivers (shops) Delivery time windows	Cooperation between partners in the chain is crucial More, but smaller vehicles, more, multi-drop (round) trips, more traffic, lower loading factor More stress on drivers (higher chance of accidents) More stress on the environment (Ultimately) receivers leaving the (inner)city

Source: De Jong et al., 2002, adapted.

Research into urban freight transport

Compared to the number of studies into passenger transport, there are not so many studies into freight transport. This holds even more for urban freight transport. In 1983 ECMT published its first major study about it. In the same period, the first academic studies arrived, most notably the one by Button et al. (1981), a concise overview of urban freight transport from an economic perspective. Ogden (1992) is a well-cited study from the early nineties, discussing many aspects of urban freight transport. Yet, he still concluded that research has a poor theoretical basis, primitive analytical framework and very little data to develop and calibrate models.

Although our intention is not to present a state-of-the-art of the field, nor to comment extensively on the work of other researchers, some statements can be made after reading the literature. In some cases, more general (non-urban or even non-spatial) theories and empirical evidence about freight transport is transferred to cities. In other cases, freight transport is modeled as a residue of passenger transport or even treated as if it were comparable to passenger transport. This is not correct, because passenger and freight transport are markedly different. A structural difference is that freight does not move itself, which explains the role of logistics and the complexity of the transport chain with

many actors and diverging interests. An example is the difference between trip planning in both cases. "Truck trips in urban areas are chained together in tours comprised of multiple delivery, pickup and mixed pick-up and delivery trips. The degree of trip chaining is so high compared to that encountered in urban passenger travel that it warrants special consideration in modeling." (Slavin, 1998, p. 2) A second major difference is the difference between trucks and passenger cars in terms of size and trip operating characteristics, while a third difference is that the number of trucks and truck trips differs considerably between location and industry (Slavin, *ibid*).

In more recent years, many case studies and various modeling and simulation studies were carried out, a development that was also stimulated by the international Institute for City Logistics (founded in 1998). Despite these efforts, OECD (2003) mentions the need for more research, especially into evaluation methods and data collection, because only in a few member countries reliable data about urban freight transport are available.

The aim of the paper is to present a method for collecting, analyzing and presenting relationships between key variables about urban freight transport that has been applied in several Dutch cities.

Methodological aspects

The method

In 2002 Connekt B.V. commissioned a study with a two-fold aim. First, to optimize a previously developed (PSD et al., 2002) method of collecting data about urban freight transport. Next, the method was applied on data about shopping centers in the inner city of Amsterdam, Rotterdam and Utrecht (TLN et al., 2003b). This led to so-called delivery profiles for specific shopping areas¹ in these cities. A second aim was to develop a model for explaining relations between key variables in urban freight transport in these cities. The global steps to develop the latter model can be summarized as:

- define the aims of the model;
- select urban freight transport issues that should be dealt with in the model;
- translate these issues into model variables;
- define relations between variables;
- develop a quantitative model.

Initial plan for a model

The idea behind the model was as follows. By building a model, a relatively simple and general applicable tool would become available. The model should be capable of dealing with data about accessibility, local economic situation (potential), discomfort (air pollution etc.), safety and overall delivery quality in shopping centers in

¹ In the USA (Niles, 2003) a study was carried out for a wider region, describing inter- and intra urban goods transport.

(inner)cities. For each of these themes a set of variables was defined. A set of questionnaires was developed, which would be used to survey delivery vehicle drivers, goods receivers, people living in the selected shopping areas, and local government officials. These data would be put into a database. Using statistical analysis, causalities between the data in the database could then be determined. These causality parameters (coefficients in the causal model) would then represent a set of reference parameters. This assumes that the data are representative for the cases and sufficiently reliable. For new cases, the approach could then be restricted to collecting a few vital metadata, mostly related with classification (e.g., about the city size and its structure or different policy regimes). Next, these metadata should be put into a spreadsheet model (to be developed), which would determine the ‘performance’ of the shopping area (benchmarking). By varying the input parameters, sensitivity analyses can be carried out. By using standardized coefficients in the model, there is no need to carry out a new case study for every additional city. Hence, the method is also supposed to save research time and cost.

Major results from the data collection and analysis

Data were collected during the surveys, even in areas known to be difficult (Meyer et al., 2001), such as deliveries per branch of industry and commodity, vehicles, O-D pairs and route choice. A so-called delivery profile was developed (see Table 2). The profile could eventually be compared with profiles of other urban shopping areas of comparable size and (spatial, economic) structure.

The dataset also enables certain estimations. For instance, the number of delivery trips is the number of deliveries per week divided by the average number of stops per (round) trip. This gives an indication of weekly freight traffic in the area. Similar estimations can be made for days of the week or periods of the day.

However, the dataset turned out to have serious flaws. Three of them will be discussed, namely variance in outcomes per variable, (useable) sample size and data from local governments. The most common way to determine variance around a mean is by calculating variance or standard deviation. The latter turned out to be very large (much larger than the mean), which prevents making statistically valid statements about many variables or about the relations between them.

A second problem has to do with the response rates. They varied between 3 and 9 % for receivers ², nearly 100% for drivers (on street) and less than 0.1% for inhabitants. The low scores for 2 out of 3 user categories mean that the answers should be dealt with in a careful way. Another problem was that many questionnaires were not completely filled in or contained ‘surprising’ answers, hence could not be used to analyze all questions.

One likely cause of these statistical ‘problems’ was most likely outsourcing of data collection. Another is a routing error in the questionnaire, despite the fact that the questionnaires were tested. The last problem relates to data obtained from local governments. They may provide data about traffic/infrastructure, economic situation and environment. In practice the officials contacted had very little or no freight traffic data, because traffic counts make no distinction between cars and other motorized

² Range of averages for all branches of industry. There were substantial differences between branches of industry, e.g., in Amsterdam between > 80% for super markets to 1% for other business.

vehicles. This is an indication of a commonly found aggregation problem (Meyer et al., *ibid*) or collection of information on an ad hoc basis. ITS is not relevant as a source of information either.

Table 2: Delivery profile for Utrecht inner city (summary).

<i>Policy issue</i>	<i>Details</i>
Economic vitality and attractiveness	<ul style="list-style-type: none"> The more than 3000 firms generate 21000 deliveries or 9000 m³ of freight per week Average dwell time is 23 years ¹⁾ 79% of the inhabitants rates the shopping climate as 'good'
Traffic safety	<ul style="list-style-type: none"> 48% of the inhabitants is satisfied with the level of traffic safety There were no deadly accidents between 1999-2001 ¹⁾ Freight vehicles were involved in 27% of all accidents, on the ring road this was 18%. In nearly all cases there was only material damage
Liveability	<ul style="list-style-type: none"> More then 50% of the inhabitants rates the living climate as good Most of the hindrance related with delivery is due to noise (36% of the inhabitants) and vibration (15%, idem)
Accessibility	<ul style="list-style-type: none"> Accessibility of the city centre is regarded as 'good' by about one third of all people, inhabitants experience less, and receivers and freight vehicle drivers mention much more problems It takes about 21 minutes to drive from the main road (city ring) to the inner city, average stay time is about 2.5 hours
Quality of delivery	<ul style="list-style-type: none"> In about 65 % of all cases small vehicles are used Delivery is evenly spread over the week About 75% takes place in the morning and 25% in the afternoon Accessibility of the area is regarded to be good and bad, the latter is due to the segmentation of the inner city (no direct connections ²⁾). The locations for delivery and pickup and the transport distance from there are regarded as 'good'

Source: TLN et al., 2003b.

Notes:

1) Most recent data;

2) Nowadays, freight vehicles are allowed to pass, which improves accessibility.

There are nevertheless some exceptions. For instance Utrecht developed a dedicated policy note, partially based on our findings, while Amsterdam also has dedicated instruments for urban goods transport, partially based on experience and partially based on the (political) decision to ban or reduce motorized traffic in certain streets or areas. Agencies in the different city quarters can have their own policies, however.

Economic data has to come from other departments than the one dealing with traffic and transportation, which is not always easy. Environmental data is usually available, but also as aggregate data for all kinds of traffic.

These data issues led to the conclusion that building a quantitative model was not feasible with these data. Instead, attention was given to building a qualitative model. This model would be used to build a spreadsheet model.

Qualitative approach

The steps to build a qualitative model are comparable to the ones for a quantitative model (see section 3.1), except for the last step. The aim was to develop a conceptual model for urban goods delivery and pickup. It should be used to identify and explain

(causal) relations between variables. The model should enable explanatory analysis in a non-numerical, yet formal way. It should also support exploration of policy alternatives, e.g., in what-if form.

Choice of variables

The first step in developing the model was to determine which variables should be incorporated in the model. A brainstorm session with Dutch experts in the field was used to choose relevant policy themes, then topics within these themes and next aspects within the topics. Finally aspects were translated into (measurable) variables, called indicator variables, because they can be used to determine whether there is a problem and its seriousness (in relation to other variables).

Table 3 gives an example for accessibility. It becomes apparent that many different variables may be relevant in the analysis.

Table 3: Variables connected with accessibility.

<i>Policy theme</i>	<i>Topic</i>	<i>Aspect</i>	<i>Indicator variable</i>	
Accessibility	Flow	Trajectory speed	Average speed	
		Reliability	Visits per time period	
		I/C	I/C in kms	
		Stay time	Hours in the city	
		Travel time	Minutes from the city's edge	
			Road structure in the shopping area	
	Valuation	Available infrastructure		
		By relevant actors	Individual perception	
	Policy			Measurement
		Traffic		Restrictions
		Parking		Ease
		Vehicle		Impact on logistics

Source: TLN et al., 2003a.

A similar table can be made for discomfort, traffic safety etc. The paper discusses accessibility only.

Defining relations between variables

A way to define relations between variables would be to use a theory that relates these and other aspects of urban freight transport. Such a theory does not exist in practice, however. Instead there is transport-economic theory, logistic models, urban development theories etc. Merging them is complex especially because of the wide range of disciplines involved.

A more practical approach is needed to link these areas. There are examples of such approaches in the Netherlands. We will mention two more recent academic studies briefly, starting with the so-called Citymodel ('Stedenmodel'; Weiss, 2001), followed by the 'GoodTrip' model (Boerkamps, 1998).

The aim of the 'Stedenmodel' is to describe urban freight transport based on a set of determining factors (22 aspects of infrastructure, including accessibility and space for freight transport, economy, discomfort and perception of these). With the instrument, one may compare various local delivery situations and classify them. Because data (and

especially economic data) are in many cases not available, the model cannot be used for precise calculations. Instead rules of thumbs and best guesses are used. For instance, by dividing (estimated) demand for goods (in m³) by average truck capacity (in m³) times load factor (%), the frequency of truck movements (trips) per time period can be estimated. The author regards his work as a theory, but it is actually a partial model of urban freight transport. The author mentions the need for more research into the discomfort related with urban freight transport, and collection of data.

GoodTrip is a computer model, which was developed to generate data about logistic quality (load factor, number of trips etc.) and so-called external quality (pick-up and delivery trips, traffic intensity, emissions etc.) of urban freight transport. The model links economic, logistic, traffic and transport and environmental data with one another, using a so-called logistic chain of urban freight transport. Also in this case, available (disaggregate) data appears as a problem. The model was used to compare alternative urban freight transport concepts in environmental and amenity terms in a qualitative way. According to the author, pick-up and delivery of goods in urban areas can be so diverse and complex that a typology in terms of trips, load factors, delivery frequency cannot be given, especially not in dynamic and quantitative terms. Instead, a static approach was used. This means that space and time (windows) play no role, enabling straightforward modeling.

Comparing these two studies, it becomes apparent, that in both cases availability and quality of data is a restricting factor for model building, and more general, analysis and explanation of urban freight transport.

The approach followed in this paper is to some extent comparable to the one used for the GoodTrip model. Data are collected for a short period of time and spatial dynamics does not play a role. Relations between causal and effect variables are established using logic and data. Such logic is a step towards a more general model. The logic was tested during expert meetings. First, examples of the logic are given, followed by a graphical presentation of the relations between causal and effect variables, using a so-called relation diagram.

The case of accessibility

In the literature there are many definitions of accessibility. For practical purposes we will define accessibility as the ease with which a delivery vehicle can reach a location to pick-up or deliver goods.

Assessing accessibility is far from easy, because one has to relate available data and models with surveys of individuals, whose perception and personal objectives bias their view of the issue.

Our approach distinguishes three layers of accessibility: system, external influences and local situation (related with driving, pick-up and delivery). We will briefly discuss one of these layers, the system layer, presented in Figure 1. In the given diagram the relations between economics, space, infrastructure and goods movement are visualized. Such relations can be one- or bidirectional (arrow with two heads) and the relations between variables or groups of variables can be reciprocal (negative sign), neutral, positive or uncertain (-/+ sign). Uncertainty arises in many to many or one to many relations. They contain a mix of relations. Relations are defined based on likelihood, no

indication is or can be given about the strength of these relations. As far as we know, there is no literature in these areas, which could deliver this kind of information. Instead we relied on expert opinions.

Description of the prospective relations

Figure 1 may be regarded as a model of the city or area. A city may be defined in terms of space, economics and transport and traffic, which are internal factors to the model. External factors are regulation with respect to vehicles, infrastructure and economics R_t (Veh), R_t (Inf), R_t (econ) and externalities or impacts like discomfort, traffic safety etc.

In the upper left corner of Figure 1 a relation between the city (or area) typology and the economic typology is shown. The layout of a shopping area consists of branch distribution, shop type and number of shops³. Infrastructure is also part of the layout, but because of technical reasons it is treated separately.

In the middle part the number of shoppers determines sales per receiver and the layout of the shopping area. But, the layout of the area also determines the number of shoppers, because a shopping area with an unattractive layout will have a lower number of visitors than a more attractive area. Economic typology is also partially determined by government regulation R_t (econ). A local government may for instance influence branch composition by not allowing a concentration of certain shop types. Economic typology determines freight volume, e.g. in general more receivers mean a higher freight volume. The variable Branch is important here, because a concentration of a few supermarkets may generate much more transport than many small shops along a street. Some shopping streets also house many non-daily goods suppliers or services, which generate less or no demand for freight. Hence, the -/+ sign points out the uncertainty surrounding branch composition.

Freight volume Vol_{fr} and freight traffic intensity I_{fr} are related via a filter called logistic organization, appearing to be a complex issue. On the one hand, there are external demands, like those from receivers with respect to time and space for delivery or type of goods. Even within branches of industry logistic formulas may show (large) differences. There is also an important external force, government regulation R_t (Veh), which co-determines logistic processes.

Non-shopping traffic I_{other} , shopping-related traffic T_{rsh} and I_{fr} determine overall traffic intensity I_{tot} , which divided by infrastructure capacity Cap determines accessibility for freight Acc_{fr} and leads to externalities for people and environment.

The right part of figure 1 contains two feedback links. First, there is a link between accessibility and economic typology. The logic is that a more accessible area is more attractive for shoppers and because of that provides a more profitable and lasting environment for business. The other feedback link shows the relation between accessibility and logistic organization. The use of external links (gray boxes) helps to reduce complexity. In subsequent sheets these externalities and impacts were described and analyzed.

³ Other goods receivers, like service providers are excluded, because they are usually irrelevant in terms of freight volume. Their passenger traffic may however substantially contribute to inaccessibility and negative externalities.

In Figure 1 three main groups of variables can be distinguished: physical conditions, economic performance and (local) regulation. These categories will also be used in the spreadsheet model of the next section.

A spreadsheet model

Aims and applications

The aims of the model are the following:

1. Indicative assessment: what is the quality of delivery in a particular shopping area? In this case the user has only access to the input module;
2. Factor analysis: which factors influence the quality of delivery in a particular shopping area?
3. Sensivity analysis: What happens if the characteristics of the study area (e.g., regulation) or technical parameters change? The user can vary the characteristics of the study area and the technical parameters.

At present, only the first aim is partially achieved.

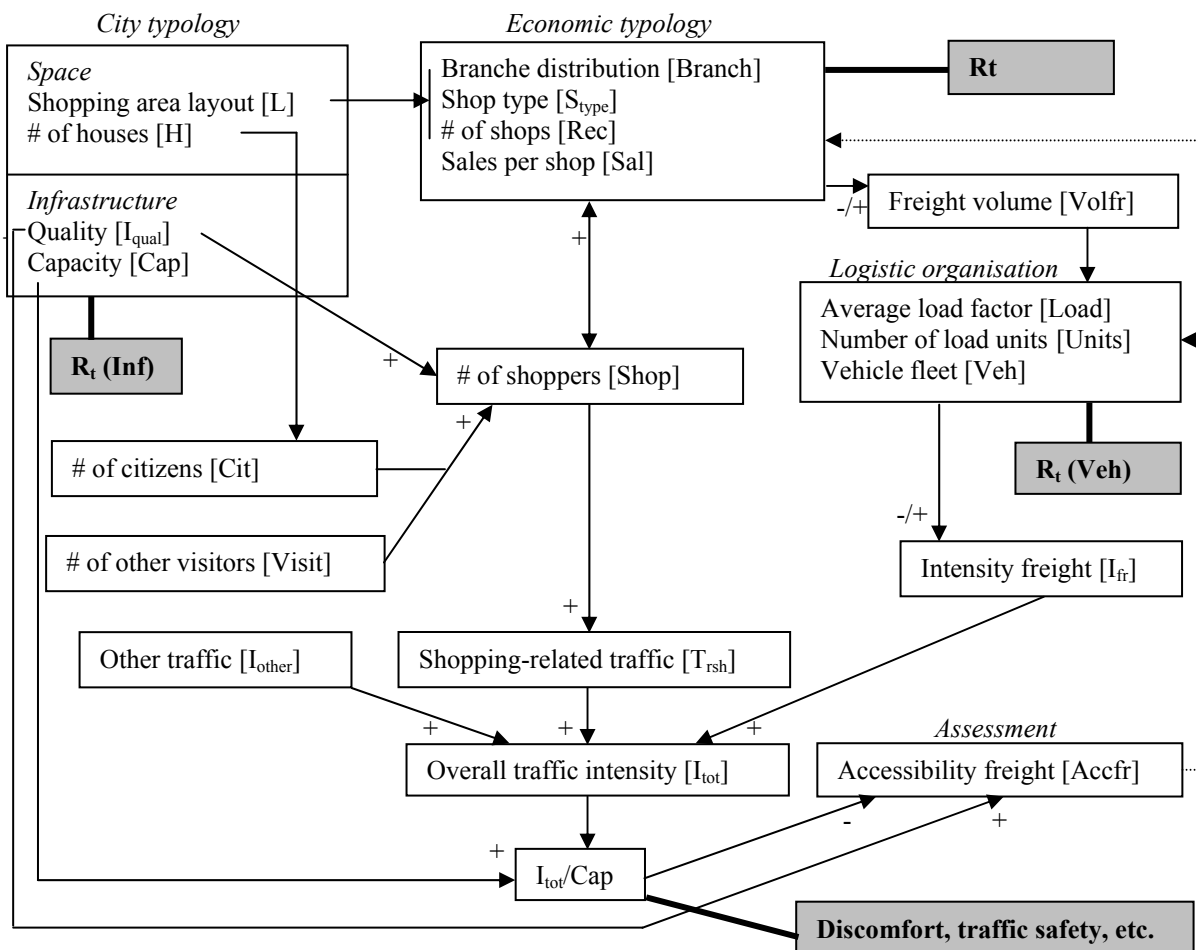


Figure 1: Relation diagram for accessibility.
Source: TLN et al., 2003a, adapted.

Application of the model

The model was built using rules of thumb and logic partially derived from the experience with relation diagrams. It has three modules: input, parameters and output. We will describe the way the model can be used in practice. The input module is used to fill the model with values. It consists of three parts: economic data, city data and applicable regulation. Table 4 shows a simplified version of this module.

Table 4: Input module for accessibility for a city.

<i>Characteristics</i>	<i>Variables</i>	<i>Value range</i>	<i>Average</i>	<i>Reference values</i>
Economic data	Size of shopping area in m ³	100.000-250.000	180.000	175.000
	Main branches of industry	Retail, services	Retail	Retail
	Supplier type	Standard	Standard	Standard
	Deliveries per round trip	5-15	10	12
	Opening hours	9.30-13.00	10.00	10:00
	Storage space	10-300 m ³	150 m ³	200 m ³
	City data	Number of unloading areas	5-10	8
Width of road		6-8 meters	7 meters	8 meters
Interference with other users		4-8 'spots'	6 'spots'	2-4 'spots'
Distance from receiver		15-50 meters	25 meters	15 meters
Regulation data	Vehicle length	Limited to 12 meters	Limited to 12 meters	Limited to 12 meters
	Physical barriers	4	6	5
	Time windows	Delivery only in morning hours	Delivery only in morning hours	Delivery only in morning hours

As can be seen, demand and supply variables are contained, as follows:

- demand in terms of transport volumes, modal choice, timing and frequency;
- supply in terms of accessibility, vehicle regulation, traffic policy and access policy.

The values in the third column of Table 4 are not from life, they are used for presentation only. The input module used to compare area data with reference data (averages from other locations) indicated that some values differ substantially from the reference values. This is logical, because no two shopping areas will be the same.

Table 5 shows part of the logic of the spreadsheet model.

Table 5: Relations in the input module of the model.

	<i>Influence on</i>
Economic variables	Transport volume Delivery frequency Vehicle choice Timing of delivery
Local policy	Vehicle requirements Traffic policy Access

Finally, the model gives an indication of the consequences of using light or heavy vehicles (larger than 12 tons) for the delivery area. Heavy and long vehicles are frequently banned from inner cities. The question is whether this is always justified. If vehicle length and weight restrictions are in power, transport companies have to use smaller and lighter trucks or vans. In this situation, for a given transport volume more vehicles are needed, hence traffic intensity will increase. Accessibility may be reduced if traffic intensity increases, but smaller vehicles are easier to use in 'restricted areas', which may dampen the reduction of accessibility. The impact of different vehicle sizes on the environment cannot be determined easily, because too many variables are involved and there is still scientific uncertainty. The model generates a provisional ranking of vehicle types. Sensitivity analysis is among the options. The model shows how the balance between the two vehicle types may change after the introduction or change of policy measures.

Lessons learned

The aim of modeling was to provide decision makers with a conceptual tool, which would improve their knowledge and understanding of urban goods transport. By showing the links between economic, traffic/infrastructure and environmental/discomfort data, the decision maker can become aware that instruments employed in one area may have a profound and sometimes 'unwanted' impact on other areas of policy. This holds especially for vehicle regulation and traffic bans. To some extent these impacts are known, but the problem is that many policy makers tend to focus only on the small areas for which they are responsible. Problems are perceived instead of (fully) understood and instruments are introduced without detailed knowledge of the local situation or about the alternatives. The lack of knowledge or (political) disinterest to invest time and money to study the system of urban goods transport may explain why many cities do not develop dedicated instruments to improve urban goods transport, but instead rely on general instruments, which have originally been developed for passenger transport and/or 'simply' start banning (particular) delivery vehicles from congested areas. The outcome may be that urban goods distribution may become even more difficult, which has a negative impact on the local economy.

With the proposed model it would be possible to design more balanced policies for urban goods transport taking care of unwanted impacts of policy. The tool is not in a stage to support such policies, yet. Improvements are necessary in the survey methodology. For example, we learned that data collected for descriptive purposes is not necessarily the type or quality of data needed for analysis and model building, because such applications are much more demanding.

To improve the quality of the dataset, data acquisition should first be improved and second, the group of potential data suppliers should be broadened. It is vital to find a way to extract logistic information from the system. It may help if suppliers of goods would be willing to participate in the study. The inclusion of (more) information from chambers of commerce would improve the economic part of the analysis. This would imply a broadening of the number of parties involved. The result would be that some of the existing gaps in the database could be closed.

A consistent and statistically valid dataset is a precondition for any kind of quantification and particularly for the definition of mathematical formulas and estimation of parameter values.

Conclusions and recommendations

There is a controversy about the impact of urban freight transport between public policy makers, transport operators, receivers and citizens in many cities. What contributes in particular to this controversy is a lack of a transparent description of local problems based on solid empirical information.

The paper discussed a Dutch method for standardized collection, processing and analysis of data about goods delivery in shopping areas. During the analysis an analytical model has been developed, which is an important leap towards a quantitative analysis of database. Because of many constraints, the development of a quantitative model was not feasible. An important constraint was the lack of an urban goods distribution theory.

Two crucial issues should be considered in new research in this area:

- a) develop a theory of urban goods distribution with these building blocks as a basis;
- b) improve the quality of data to be eventually used in this theory. This should particularly relate to
 - o formulating more dedicated research questions dealing with existing gaps in the dataset;
 - o making the dataset more dynamic. If time-series were available, then conclusions about the impact of specific policy instruments, about changes in logistic practices and their local impact etc. would be possible;
 - o using information about logistic trends to interpret and restructure the dataset and improve the relation diagrams and spreadsheet model;
 - o separating the transport requirements of different receiver categories and in particular improve the data about small receivers.

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