End consumer goods movement generation in French medium urban areas

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ABSTRACT

End-consumer movements, defined as the movements made by the consumer transporting the purchased goods, are identifies with shopping trips. Whereas the logistics movements (freight distribution and urban part of the supply chain) are well studied in city logistics and urban planning, the end-consumer movements are usually related only to people movements. This paper presents a new modelling approach to characterise the shopping trips in a city logistics point of view, in order to connect these movements with those belonging to urban freight distribution in the supply chain. We present a sequential model built from the data of the Trip Surveys made in France in 2006, more precisely for the Lyon urban community. We present the main results issued of the various simulations in a short-term planning horizon.

INTRODUCTION

In the last decades, city logistics has been developed to deal with the main problems of urban freight distribution, studying freight movements in urban areas and proposing solutions to reduce congestion and pollution as main problematics. Recent studies have defined and characterised the different movements of urban goods (Patier, 2002; Ségalou et al., 2004; Russo and Comi, 2006). Two main approaches have been proposed for urban freight modelling: in classical modelling approaches, these movements are related to a quantity of goods (Sonntag, 1985; Ortuzar and Willumsen, 2001). However, the vehicle trip seems a better unit for modelling approaches which compare freight and passenger transportation, as the congestion, pollution and other problems derived from the interaction of freight distribution with the transport of people can be reported to the public soil sharing by the vehicles involved in both types of transportation (Routhier and Aubert, 1999; Patier, 2002; Regione Emilia Romagna, 2005).

Although the classification of movements related to urban goods contains several categories (Patier, 2002; Ségalou et al., 2004), two of them are predominant and represent about 90% of the overall urban goods movements: *establishment supply movements*, which are related to freight distribution between the different activities, and *end-consumer commodity movements*, where the purchased goods are moved by the consumer, related to shopping trips. The first group of urban freight movements, which corresponds to the exchange of goods between different establishments, has been one of the most studied subjects in city logistics research.

End-consumer movements, less studied in urban freight transport science, is an important component of urban freight transport, representing about 50% of the total km. PCUs (Passenger Car Units) of urban freight transportation, where establishment supply movements represent only 40 % of the total urban freight-related vehicle movements (Patier, 2002). In France, shopping trips represent 10% of the total person trips in working days, i.e. from Monday to Friday, and 25% in Saturday . In terms of pollution, the urban transport of goods, including end-consumer movements, produces about 25% of the total CO_2 emissions for transport, 35% of the NO_x emissions and 40 to 50% of the particulate (Ségalou et al., 2006). Moreover, mutations related to the development of new technologies and consumption trends have an important impact on the shopping behaviour, which influences the different travel habits, so the characteristics of the shopping trips (Desse, 2001). Land use strategies proposed by public administrators will have also an influence on commercial activities location and proposed services (Routhier et al., 2001). Moreover, the location of retail activity areas has an influence on freight flow generation, in both sides of the extended supply chain (traditional freight distribution and end-consumer movements). Although the contribution of end-consumer movements to the urban flows of motorised vehicles is important, they are rarely taken into account in city logistics policy and transport planning and optimisation.

The aim of this paper is to propose a new trip generation model for characterising the shopping trips made by private car, in order to evaluate the shopping travel flows for a given urban area. In next section we will present a brief overview on shopping tip modelling main studies, as well as on the main operative freight-related trip generation models used in European cities. Then, the shopping trip generation modelling methodology, based on the available data for the urban community of Lyon (France), is presented. Finally, the first results of the modelling methodology are shown.

AN OVERVIEW ON SHOPPING TRIP GENERATION MODELLING

Trip generation models relate trip generation rates to land-use and household characteristics. In general, the focus of research is the number of trips generated and their geographic distribution. Most of these models are integrated in other methods like the well-known family of classical four-steps models (Ortuzar and Willumsen, 2001), which is commonly used in general trip characterisation. The socio-economic characteristics of the trip makers are assumed to be significant determinants of travel behaviour because the factors determining the number of all types of trips are assumed to be the same as those for shopping trips (Cubukcu, 2001). These factors are, among others, income range, age, gender, employment status, auto ownership, and household size. The physical and demographic characteristics of the area include: employment, population, and density. However, it is reasonable to believe that there are metropolitan area characteristics and trip maker characteristics which impact is significant only for shopping trip generation rates (Cubukcu, 2001). However, most of the studies dealing with shopping trips specifically are in general related to the regional or national level few models are proposed to characterise shopping trip generation factors in a urban context.

Vickerman and Barmby (1984) estimate the number of weekly shopping trips and total weekly shopping expenditure by using simultaneous equations with diary data. The explanatory variables are household size, income, auto ownership (obtained from data surveys), and two calculated variables: shopping attraction index and shopping travel cost index. However, the levels of explanation of the models are not satisfactory. In a follow-oup study, Vickerman and Barmby (1985) apply the binary logistic regression model to the same diary data, calculating the attraction index using physical characteristics of the shopping centres, and the trip cost index is calculated by using the costs associated with the completion of a trip. The results point to evidence on the insignificance of car ownership and a significant effect of household size. However, the parameters for the attraction index and the shopping trip cost index are found to be more stable across different trip making levels.

Badoe and Steuart (1997) estimate the total number of housing shopping trips by using such variables as household size, number of workers, number of licensed persons, and number of vehicles. Regression is used with 1964 and 1986 data for Greater Toronto Metropolitan area. The different model specifications provide little explanation of the variation in household shopping trips. Household size, which is one of the most common variables in previous studies, is found to have much less explanatory power, compared to previous studies. The authors conclude that different approaches are needed to explain the variation in non-work trips, including shopping trips.

Cubukcu (2001) proposed a general transportation rate model to find the main factors that affect the total number of shopping trips in North American metropolitan areas, adding to classical models some hypothesised factors to model the effects of the new technologies, such as e-commerce, teleshopping and grocery home delivery services. The developed model estimates the total annual number of shopping trips, related to three types of explanatory variables: shopping related characteristics of the metropolitan areas (total number of retail establishments, population density, general climatic conditions), socio-economic characteristics of the trip makers (age, income), and technology-related trip maker characteristics (computer ownership, modem ownership). The model is applied to a data set for 49 metropolitan areas with population over 1 million in 1995. The statistical analysis of the modelling approach show which are the most significant factors, although no other variable combinations are proposed. The only variable that is found insignificant is the mean income.

Ségalou et al. (2002) propose a modelling methodology in an extended city logistics approach. The authors use a different shopping trip definition relating it to urban goods and not to the people that buy or carry them, in a city logistics point of view. A shopping trip is defined as the trip which origin's purpose is shopping. There is however an exception, the household-shopping-household journeys, also known as shopping shuttles which have been considered entirely. This definition has been adopted with the purpose of comparing shopping trips with urban distribution solutions, more specifically to evaluate the effects of new distribution and technological solutions like home delivery, e-commerce, distribution points, etc. A regression-based generation model is proposed, considering as main variables the retail offer of an area, the population, the motorization rate and the distance of each zone's centroid to the main city centre. A gravity approach for trip distribution is also proposed. This model, which is specifically built to characterise the purchasing trips in a urban context, has been calibrated and applied to the urban area of Dijon (Toilier et al., 2005).

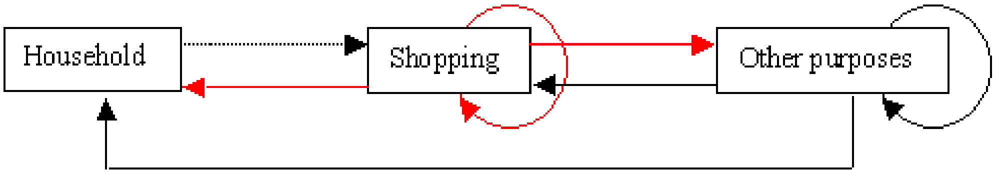

Figure 1: Main trips related with purchasing activities (Toilier et al., 2005)

FREIGHT FLOW GENERATION MODELS FOR TRANSPORT POLICY DECISION SUPPORT IN EUROPEAN URBAN AREAS

In Europe, several cities have started to use traffic flow generation and distribution models as decision support tools to policy making. Although both passenger and freight flows are considered in some of them, they are estimated using separate models. We will focus on freight trips generation models currently used by public administrations. The three most used tools are FRETURB (France), WIVER (Germany) and recently, also City Goods (Italy).

At the end of the 80's the model WIVER was developed by Sonntag (1985) in connection with the survey data collected in three cities of West Germany. This model is based on several in-depth surveys carried out at nearly 9000 premises (Munich, Berlin, Hamburg) and specific surveys of drivers on their traffic behaviour. The complexity of interactions explaining the generation of traffic required considerable data collection work. The determination of traffic O/D is obtained in four stages, in each area by: the calculation of the round origins, the selection of destinations in comparison with the origins, the connection between origins and destinations, and (4) route construction. These calculations made it possible to obtain the share of the commercial traffic in the total traffic (in terms of vehicle flows) and the map of O/D commercial traffic flows between different areas, becoming a diagnosis tool for commercial traffic as well as a quantification of urban platform impacts. Lohse (2004) transferred the WIVER model to a general framework backed up by a system theory and included in the software program VISEVA, which can estimate both passenger and goods movements in urban areas. However, the shopping trips follow the classical trip estimation framework.

FRETURB is a tour-based model of urban goods flow generation, which, oppositely to classical approaches, considers the vehicle movement as the statistical unit (Routhier and Aubert, 1998). The vehicle movement is defined as a delivery or a pickup associated to a given establishment, a vehicle size, a mode of management and logistic behaviour). Nowadays, the "pick-up and delivery model" which estimates commodity flows between all the economic activities of a town is the most developed. It is a regression-based model calibrated by large establishment-driver surveys. It is derived from the empirical survey data resulting from statistical validation. Those surveys brought to light relevant relationships between the behaviour of shippers (spatial and economic data) that of hauliers (operations transport). As input data, it requires a local establishment database but no large local surveys. As we stated above, the "purchasing trips model" is in an improvement phase, and other two modules, the "flow distribution module" and the "environmental rates module" are being tested (Routhier and Toilier, 2007). Available as software since 2000, this module is nowadays used in more than 20 French urban communities (including most of the main French cities like Paris, Lyon or Lille, among others).

City Goods is the urban freight demand model based on the framework of Gentile and Vigo (2007), developed for the Emilia-Romagna Region in Italy. According to the authors, the model deals with two main questions. The first takes place when a given activity (a fortiori a given zone) generates movements belonging to different supply chains, and the second when a vehicle performs many deliveries or pick-ups in a tour. The goal of City Goods is to build a demand generation model in order to estimate the yearly number of operations generated by each zone, following a sequential procedure similar to the well-known four steps model for the transport of people. The difference with the other freight-based models is that the data collection methodology and the modelling architecture have been developed simultaneously, following the example of Freturb (Regione Emilia Romagna, 2005).

In order to introduce the new forms of distribution and retailing (e-commerce, home delivery service) and the impacts of land-use policies in the extended supply chain of urban communities, the end-consumer movements have to be identified and estimated. Moreover, the results of these estimations have to be comparable to those of the freight distribution flows calculated by the different models. For these reasons, it is important to generate the shopping trips in a city logistics point of view.

THE PROPOSED MODEL

As shown above, classical shopping trip generation models are not well adapted because the factors and mechanics that define shopping trips are different than those observed in "all purposes" trip generation. In addition, the input data is not adapted to shopping trip generation modelling, because the information is obtained from surveys which are in general made to characterise the overall trips, not only those related to a purchasing activity. For this reason, several fields which could be interesting for shopping trip characterisation are not surveyed. Moreover, the information obtained in these surveys do not always allow to introduce several variables like household income, car ownership, internet possession or other technological or financial information, because of a lack in the survey answer or a low accuracy of the obtained information. Another problem is related to the availability and the comparability of the data used to test and calibrate the models. For these reasons, we propose a modelling methodology that will need as input data standard files, available for each French urban community, such as censorial and establishment register information files. Therefore, household trip surveys, which follow a French standard procedure that has been applied to urban areas of different sizes, is used to test and calibrate the different models.

Definitions and model description

As we observe from several household trip surveys, shopping trips are included in more complex trip chains. In all these chains, commercial activities are related to two connected shopping trips:

- An inbound trip, arriving at the considered commercial area. This is the part of the trip chain that is defined as shopping trip in classical passenger trip characterisation.
- An outbound trip, starting at the considered commercial area, where the goods that have been purchased are also travelling.

Although the end-consumer goods movements take place only when the outbound trip starts, they are closely related to inbound trips, as both types of shopping trips are always made consecutively one after the other (see figure 3). A particular type of shopping-related trips is that of trips which purpose activity at the origin and the destination is related to shopping. The

Shopping-Shopping trips can be considered as inbound trips for the arriving zone and outbound trips for the departing zone.

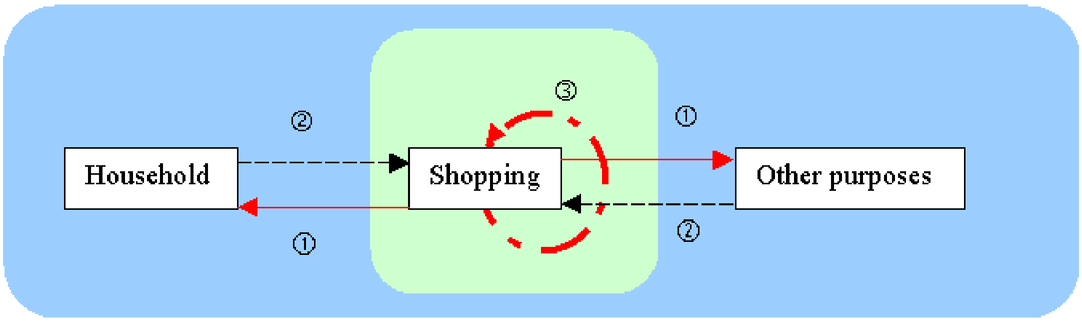

Figure 2: schema of the shopping-related trips

The proposed methodology will be developed using the available data of the urban community of Lyon, which has about 2.000.000 inhabitants and 800.000 households. The main data sources are an extract of the register file of companies (SIRENE file) of the chosen area, the corresponding census database (INSEE file), and the 2006 personal trip survey, which follows a French standard (CERTU, 2008). In this survey, the urban community of Lyon is divided into several small zones, grouped into macro zones (see Figure 3). However, it is important that the methodology will be able to be applied to a chosen urban area or generalised into a model ready to be used on any urban area without the need of a calibration and a testing phase.

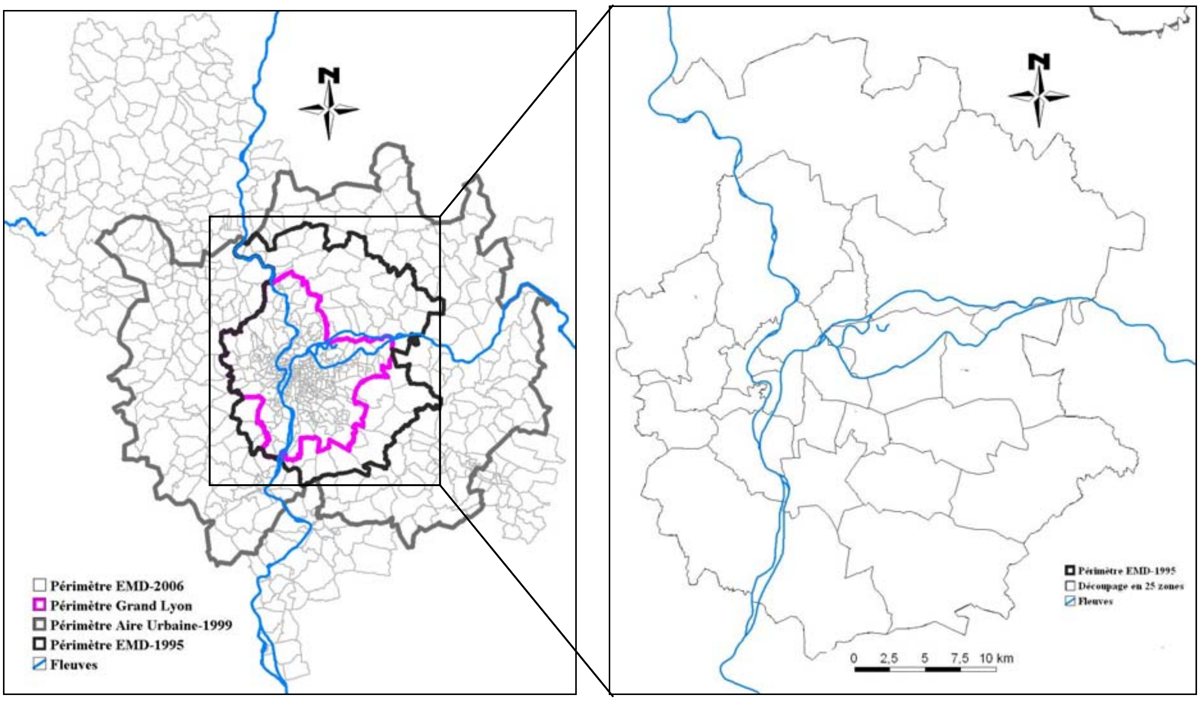

Figure 3: Maps of the Lyon urban area and the considered zones (source: L. Bouzouina, LET)

The private car shopping trips in a urban context are the end-consumer movements which can be directly compared to the other urban logistic movements. The model will be able to generate these private car shopping trips at each zone, for both emission and attraction. In a first time, we will characterise the shopping trips at the shopping destination, which represents both the inbound trip's destination and the outbound trip's origin. We will note the number of private car trips at a shopping destination *i* the private car shopping attractiveness of *i* and noted ${}^{O}SA_{PC}$i. We will estimate ${}^{O}SA_{PC}$i as the attraction trips at the shopping destination zones made by private car. Then, another attraction model, calculated at the destination of the outbound trip, is proposed. Analogously, an emission model, calculated at the origin of the inbound trip, estimates at each zone of origin the number of trips having a shopping activity at destination and other purpose at the origin. This model presents many similarities to the attraction model at the final destination because the households are the main source of inbound shopping trips and the main destination of outbound shopping trips. In both models, the shopping-shopping trips are excluded. These trips will be then estimated in a fourth time. Following the general trip generation rate modelling framework (Cubukcu, 2001), the number of shopping trips Y_{si} made by private car starting at or arriving to zone *i* can be formulated in the following way:

$$Y_{si} = f\,(A_{si}, X_{si}, T_{si})$$

where Y_{si} is the total number of shopping trips generated in section *i*; A_{si} the vector of the shopping activity characteristics at zone *i*; X_{si} the vector of the socio-economic characteristics of people and households belonging to zone *i*; and T_{si} the vector of technology characteristics. Each vector contains a set of possible variables that can be included in the shopping trip generation estimation model.

The vector A_s contains the following characteristics:

Nr_{SMC} : Number of small and medium stores;
Nr_{BS} : Number of supermarkets and big commercial surfaces;
Nr_{VBS} : Number of hypermarkets and similar stores;
$Nr_{emp\text{-}SMC}$: Number of employees in the section's small and medium stores;
$Nr_{emp\text{-}BS}$: Number of employees in the section's supermarkets and big commercial surfaces;
$Nr_{emp\text{-}VBS}$: Number of employees in the section's hypermarkets and similar stores;
$Nr_{emp+400}$: Number of employees in the section's stores of more than 400 m^2;

These characteristics are obtained by aggregation of the Lyon's urban area SIRENE data.

In addition to these characteristics, the importance of concentrated commercial activities in a peripherical area is an element which can be interesting to observe (Ségalou et al., 2002). The only accurate information that can be obtained with the available data is the presence of a Commercial Centre in a peripherical zone. This variable is defined as follows:

CC_e : Presence of an extra-urban commercial centre, represented by a binary attribute which takes the value 1 if at least one extra-urban commercial centre is located inside the section's perimeter and 0 otherwise.

The population socio-economic characteristics vector, X_s, contains the following characteristics:

POP: Population of the considered section
Nr_H: Number of households of the considered section
D_{POP}: Population density;
D_H: Household density;

These characteristics are obtained by extraction of the INSEE census data of Lyon's urban area. The local administrations have access to these population and household censorial data files. Other interesting databases are obtained from the household trip surveys, both local or national, or the Commerce and Industry Chamber national or regional surveys, although these data are less accessible and not available for all the medium urban areas. For these reasons, we only used INSEE files to build the vector X_s.

Current surveys do not have enough elements to well define tele-shopping usage trends, and other behavioural trends related to home delivery. Moreover, current data sources do not allow to characterise the relations between teleshopping trends and car usage behaviour (Beauvais, 2005). For these reasons we will not include in a first time the effects of teleshopping and home delivery services in our model; they will however be considered in a conceptual modelling framework, in order to define them when standard data will be able to characterise these effects.

First approach: one category of urban space

Following this methodology, we assume that the shopping trip generation follows a linear function. Then, the best estimation model for the shopping attractiveness will be obtained by multilinear regression, starting from a model with one variable and introducing and/or taking out variables. The same procedure will be repeated for each model. We used the modules of Microsoft Excel 97, more precisely the linear regression option applied to the entire data set. The best linear regression that we obtained has the following formulation:

$$^{O}ST_{PC} = a_0 + a_1.POP + a_2.Nr_{SMC} + a_3.Nr_{emp-BS} + a_4.Nr_{emp-VBS} + a_5.MR$$

We report on Figure 4 the private car trips at each zone which purpose at destination is shopping. The discontinuous curve refers to shopping trips directly extracted from the 2006 household trip survey. The continuous one represents the estimated shopping trips using the linear regression presented above.

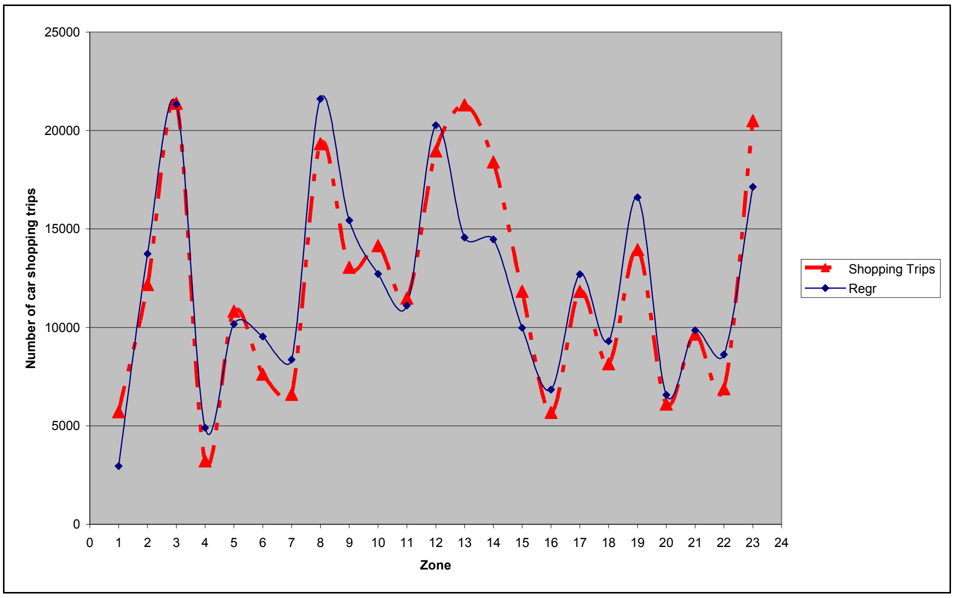

Figure 4: Comparison between estimated shopping trips from 2006 survey and first approach results for the Shopping Attractiveness (in number of trips)

The resulting approximation function has a R^2 = 0,74 and a standard error of 2820,95. Moreover, we observe a bad fitting in almost half of the zones. Another estimation method has to be found, since the quality of the approximation is not satisfying.

Second approach: three categories of urban space

Urban trip surveys made by public administrations in France follow a standard which proposes various types of zone divisions for a city. One of them, which is easy to identify and to explain to citizens, is the ring zoning cut-out. Each urban community is divided into a number of pseudo-ring areas which present similarities in demographic, density and urbanistic aspects. The main urban area, known as *central urban area* in this study, contains the main city of the urban region and sometimes also other urban suburbs which can be assimilated to the main city, because of a continuity of the urban landscape. The cities of the *near periphery*, which are the urban zones limiting with the central urban area first ring. The rest of towns of the extended urban community belong to the *far periphery*. The ring division of the far periphery will not be considered for modelling purposes, as we observe that the number of rings is different for each urban area (only the first and the second are standardly defined in all French urban communities) and after a first set of regressions we observe that the behaviour in the each ring of the far periphery does not present important differences in terms of factors and coefficients that are included in the model.

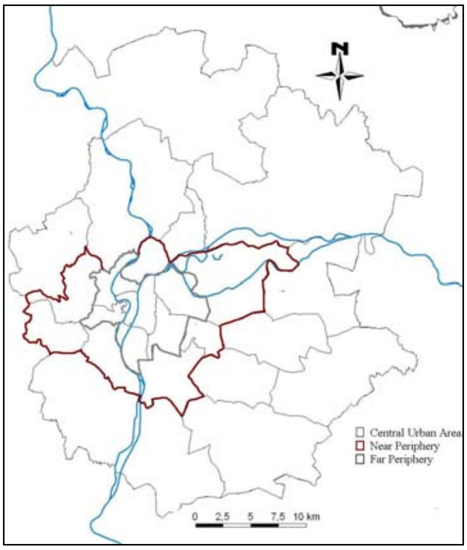

Figure 5: The three categories of urban space considered in our study

ESTIMATIONS AND MAIN RESULTS

Private Car Shopping Attractiveness estimation

The private car shopping attractiveness is defined as the number of shopping trips generated by the commercial tissue of a zone.

$$^{O}ST_{PC}^{CUA} = a_0^{CUA} + a_1^{CUA}.POP + a_2^{CUA}.Nr_{SMC} + a_3^{CUA}.Nr_{emp-BS} + a_4^{CUA}.Nr_{emp-VBS} + a_5^{CUA}.MR$$

$$^{O}ST_{PC}^{CUA} = a_0^{NP} + a_1^{NP}.POP + a_2^{NP}.Nr_{SMC} + a_3^{NP}.Nr_{emp-BS} + a_4^{NP}.Nr_{emp-VBS} + a_5^{NP}.MR + a_5^{NP}.CC_e$$

$$^{O}ST_{PC}^{CUA} = a_0^{FP} + a_1^{FP}.POP + a_2^{FP}.Nr_{SMC} + a_3^{FP}.Nr_{emp-BS} + a_4^{FP}.Nr_{emp-VBS} + a_5^{FP}.CC_e$$

Figure 6 shows the number of private car shopping trips obtained from the Lyon urban community 2006 personal trip survey compared with the 3-category linear regression approach. For the Lyon urban area, zones 1-8 represent the CUA, which is characterised for presenting two administratively different cities (Lyon and Villeurbanne) that have a spatial and urbanistical continuity. Zones 9-16 represent the NP and the other zones represent the FP.

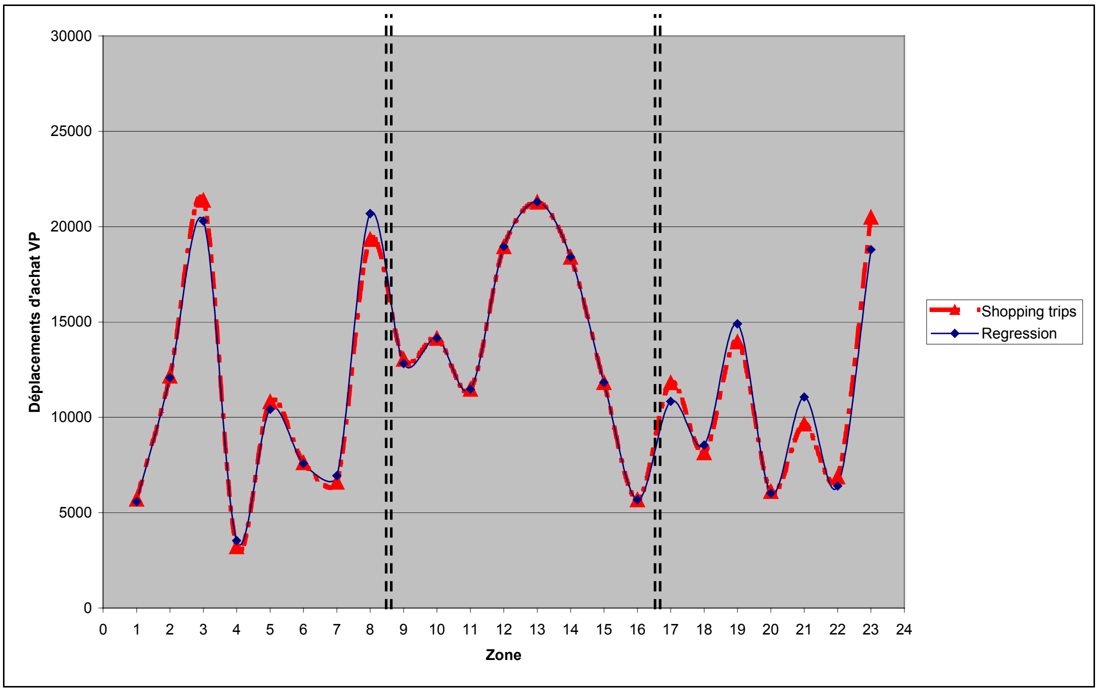

Figure 6: Comparison between estimated shopping trips from 2006 survey and model approximations for the Shopping Attractiveness (in number of trips)

The 3-category approach is able to show the different influence of the supermarkets in the urban area: in the CUA, the corresponding coefficient is negative, whereas in NP and FP zones it is positive, which corresponds to the fact that the usage of private cars in peripherical supermarkets is predominant, but much less important in the main city zones. We also observe that the motorization rate is not influent in the far periphery, because each zone of this category has similar characteristics in terms of number of vehicles. Another variable that appears essential is the presence of a Commercial Centre in periphery. If this variable is not used, the approximation in zones 12-16 and 19-22 has a similar quality than the estimation obtained with the one-category approach. A Commercial Centre does not only contains very big stores, but also small satellite stores, and sometimes services and restaurants. This aggregation of commercial activities has an influence on the private car activity of the zone. As we observe in Table 1, the R^2 values are high, and figure 5 shows a better fitting than in one-category approach. In zones 6 and 7 (CUA) and 13 to 15 the approximation is very close to the survey shopping trips.

Table 1: R^2 and P value for the shopping attractiveness estimation

Category	R^2	Standard error
CUA	0,98	2864,92
NP	0,98	2779,27
FP	0,99	2348,88

Inbound shopping trips at the origin and outbound shopping trips at the destination

Using the same approach, we obtain the best linear regressions for the outbound shopping trips at the destination. In this case, we have taken out the shopping-shopping trips, which will be characterised separately. These trips are calculated at the destination place, and the household density appears as one of the main variants, which was not the case in the shopping trip attractiveness estimations. The equations of the best linear regression model for outbound shopping trip attraction are:

$$ST_{PC}^{CUA} = a_0^{CUA} + a_1^{CUA}.POP + a_2^{CUA}.Nr_{SMC} + a_3^{CUA}.Nr_{emp+400} + +a_4^{CUA}.MR + a_5^{CUA}.D_H$$

$$ST_{PC}^{CUA} = a_0^{NP} + a_1^{NP}.POP + a_2^{NP}.Nr_{SMC} + a_3^{NP}.Nr_{emp+400} + a_4^{NP}.MR + a_5^{NP}.CC_e + a_6^{CUA}.D_H$$

$$ST_{PC}^{CUA} = a_0^{FP} + a_1^{FP}.POP + a_2^{FP}.Nr_{SMC} + a_3^{FP}.Nr_{emp+400} + a_4^{FP}.CC_e + a_5^{FP}.D_H$$

We observe some differences respect to the Shopping Attractiveness estimation models. This can be explained by the

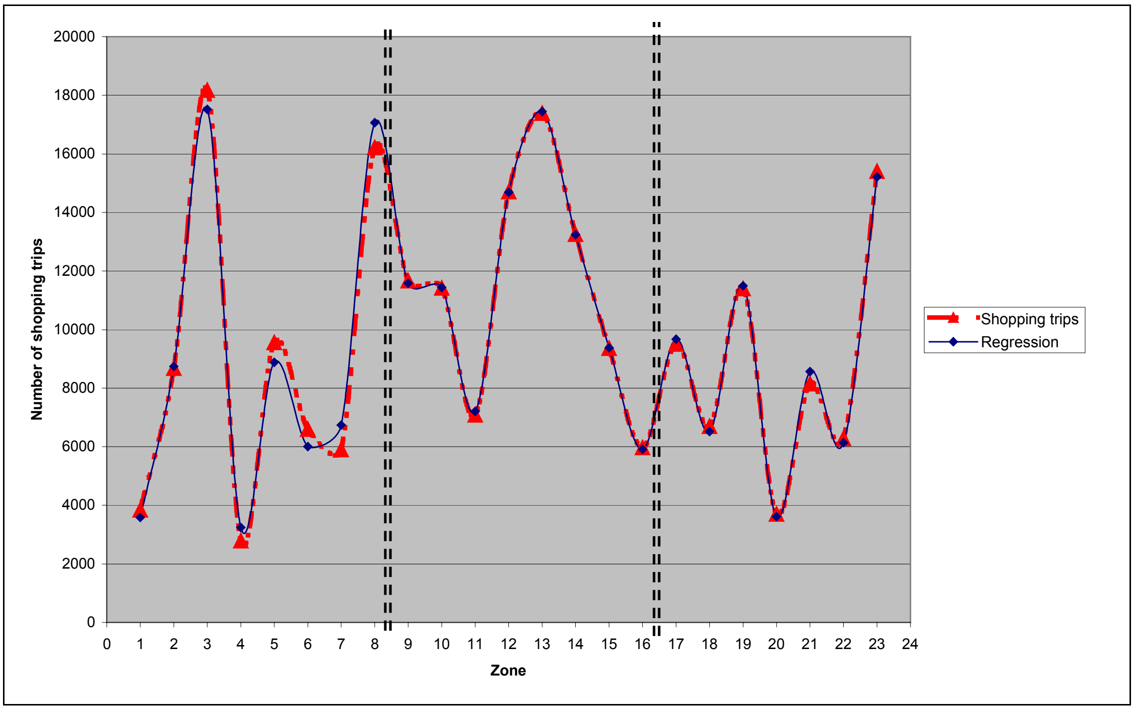

Figure 7: Comparison between estimated shopping trips from 2006 survey and model approximation for Outbound Destination (in number of trips)

In the same way, we apply the same regressions to the inbound shopping trip emission (at the origin of the inbound trip). We report the results of the outbound shopping trip attraction in Figure 7 and those of the inbound shopping trip attraction in Figure 8. The R^2 the P value for both approximation methods are reported in Table 2. We observe a better fitting for the outbound trip attraction than for the inbound trip emission. This can be explained by the fact than the number of work-shopping trips is not negligible, and represents about 10% of the total inbound shopping trips. At the moment, any variable characterising the overall working activities has not been taken into account.

Table 2: R^2 and P value for both outbound trip attraction and inbound trip emission

Outbound trip	R^2	Standard error
CUA	0,91	1968,22
NP	0,98	1855,68
FP	0,94	1423,12
Inbound trip	R^2	Standard error
CUA	0,92	1530,05
NP	0,90	1720,71
FP	0,91	1712,38

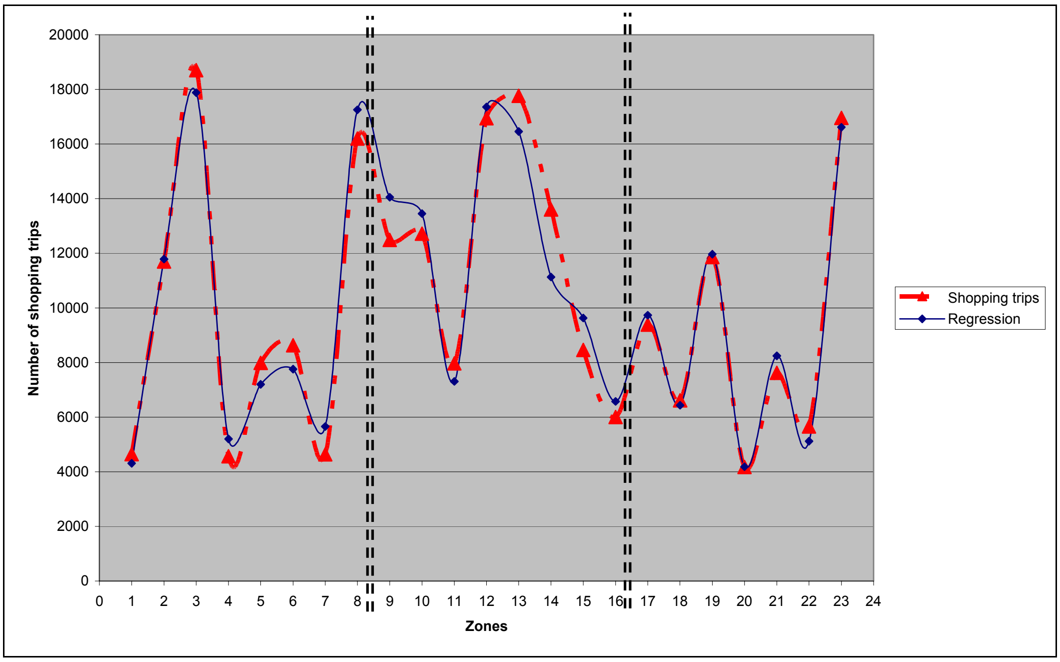

Figure 8: Comparison between estimated shopping trips from 2006 survey and model approximation for Inbound Origin (in number of trips)

Shopping-shopping trip generation

The shopping-shopping trips present the particularity than in both the origin and the destination the purpose is the same: a purchasing activity. The shopping-shopping trips can be defined as a percentage of the overall trips arriving at shopping places. This percentage varies on each zone, and will be related to the commercial activity.

Policy-oriented usages of the proposed methodology

The proposed framework allows to make previsions of the commercial attractiveness (in terms of shopping trips). It estimates the number of shopping trips arriving to a considered zone to purchase goods and also the origin and the final destination of respectively the inbound and the outbound shopping trip. For reasons of comparability with the freight distribution at the stores, the models estimate the trips made by private car.

In order to study if the size of the city has a strong influence in the shopping trip generation rates, we have chosen two urban areas of different size: Lyon and Dijon. The first urban area is 5 times bigger than the second (number of inhabitants). We observe lower regression coefficients respect to the models applied specifically for one city, but the difference is small (less than 5%). In another hand, the model is able to well estimate the commercial attractiveness in terms of shopping trips for both cities. A deeper study using the data of 3 to 5 urban areas would be interesting to set the coefficients and to obtain an estimation model to be applied to any French non Parisian urban area. Paris being a urban region, it presents some particularities that are not observed in other French cities. For this reason, a specific model can be developed only for this particular area.

Possible uses of this can be related to both passenger and freight transportation, and also to marketing and real estate fields. In transport policy, shopping trip generation rates can be used to characterise the shopping trips. Using a classical distribution model (Ortuzar and Willumsen, 2001), the private car shopping trip O/D matrix can be obtained, then a macroscopic value of the travelled distances for shopping purposes would be calculated. Then, this simulation methodology can be integrated in a general simulation framework which considers both logistics and end-consumer movements (Figure 9).

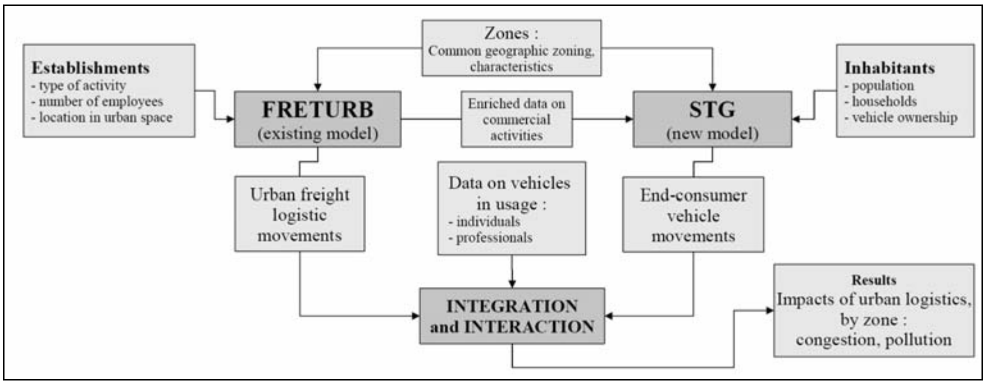

Figure 9: Chart of an integrated simulation methodology that considers the main freight-related movements in a urban context (Gonzalez-Feliu et al., 2009)

From those results, different policy-oriented uses can be made. We will focus on those related to city logistics planning and policy. The main use of an integrated methodology using as input data both a population and an establishment censorial file is to simulate strategic planning scenarios to estimate the impact of urbanistics, normative or other policy actions in the global freight movements trends. Another use can be to study the limits of several policies (Gonzalez-Feliu et al., 2009). It is important to note that the new distribution services (home delivery, proximity reception points, etc.) have a direct impact on shopping trips. In order to simulate the substitution of current practices by these new distribution services, the shopping trips by private car have to be characterised in order to define and simulate the substitution trends (from current shopping trips to the new distribution routes).

Another important usage of the generation models can be related to the commercial supply strategies. In urbanistics strategic planning, it can be interesting to know the effects of a new commercial centre opening, and how it changes the global commercial supply system in terms of private car trips.

CONCLUSION

In this paper we presented a new modelling approach for shopping trip generation, in order to reproduce an estimation of end-consumer goods movements which would be able to be compared to freight distribution trips. Considering only the private car shopping trips, which are those that interact with freight distribution trips, we developed a modelling framework based on linear regressions which follows the fact than a shopping trip is not isolated but belongs to a more complex trip chain. Moreover, each purchasing activity is related to two shopping trips: the inbound trip arrives to the shopping activity, and the outbound trip starts at this activity, and is the trip where the purchased freight is carried inside the private car.

Another important element of shopping trips in urban areas is that each zone does not have the same characteristics. Following the administrative typology of rings to classify the urban community's towns, we divided the considered zones into three categories: the Central Urban Area (CUA), which is the main city's area, the Near Periphery (NP), which represents the first ring, and the Far Periphery (FP), which contains all the other towns of the urban community.

Although the number of individuals for the linear regression analysis is small in the three categories approach (the data of the studied urban community is divided into 23 zones), we observe that the estimations have a much better fitting that the classical one-category approach. The shopping trips at each retailing zone is well estimated, and similar results are obtained for the outbound trips. However, the inbound trips are less well estimated due to the influence of working activities (no information about the overall number of employees for all the economical activities is included).

In order to improve the model, and to define an approach adaptable to each city, we have applied this methodology to a data file containing zones of two urban areas of different size. The main results are encouraging (similar regression coefficients and good approximations in both urban areas), and a deeper study is in process. Moreover, a better characterisation the Commercial Centres, as for example defining them by their surface or their total revenue, have to be studied.

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