A PROPOSAL FOR A TRANSPORT DEMAND MODEL FOR NON-WORK TRIPS

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1 INTRODUCTION

Understanding non-work and recreational travel is becoming fundamental due to its growing importance upon people’s lives and the whole transportation system. This paper reports on efforts to demonstrate a methodological approach to modelling non-work trip generation and distribution on Italian motorways and major roads. The main purpose of the work is to implement and analyse the application of classic traffic modelling schemes to non-systematic phenomena such as holiday trips. Traditional trip generation models for systematic trips have almost always excluded the impact of non-work trips (Lockwood and Demetsky, 1994; Polzin et al., 1998), due to the complexity of finding useful data and treating them for calibrating models. Furthermore, it is very difficult to evaluate the connection between a non-systematic phenomenon and mathematical variables. Our challenge is to fully understand the structure of recreational trips by investigating their relationship with social, demographic and economic variables.

Our principal aim was to predict traffic conditions, with reasonable accuracy, in order to be able to give advance warning of possible major congestion points. The approach had to take into account the special nature of recreational trips: they are non-systematic and seldom follow a regular pattern as work trips do. With such models it should be possible to make middle-term traffic forecasts with a reasonable degree of accuracy. These models are becoming increasingly important for the creation of real-time services for drivers and improvement of the quality of service on motorways and major roads. By means of electronic and telecommunication devices (GPRS, GPS, WAP) the user will be informed of predicted traffic conditions either on the whole network or on precise origin-destination paths.
In this work a preliminary research was carried out to gather and analyse statistical data, because the calibration was performed making specific surveys, but only using existing data. The model does not aim to reproduce exactly the travel demand on the network, rather to describe the principal features of non-work trips and then to predict user choices in those particular situations. Therefore, user choices were deduced indirectly from data regarding hotel accommodation, for example, or from traffic data.

Two kinds of non-work trips have been recognised and, as a consequence, two sub-models have been used. The first is a basic model system, which calculates only the number of trips involving hotel or boarding house accommodation “T_Hotel”. Due to the lack of data available, it was not possible to estimate day trips and trips to holiday accommodations owned or rented by travellers, by means of the basic model. Therefore a second model was built to deal with other types of trips, mainly day trips “T_Day”.

2 THE BASIC MODEL SYSTEM

A first model system was built to describe the basic phenomenon for those trips related to spend one or more nights away from home. Following the classic approach of partial share models the system is divided into 5 steps:

1) Trip generation model;
2) Trip distribution model;
3) Choice of departure month model;
4) Choice of departure day model;
5) Choice of departure period model.

These five models describe the rational construction of the trip, from the decision to undertake the trip to the choice of destination and, the month, day and period (8 hours) when the journey will take place. All the coefficients of these models were estimated using statistical data published by the Italian statistical institute (ISTAT) and traffic flow data provided by motorway concessionaires.

The trip generation model is based on a linear regression model that uses variables related to household size, composition and income\(^1\). It gives the number of trips per household per year for each Italian region, which has been assumed constant for all towns within the same region, and refers to trips by cars. The other four are all Logit models, calibrated with the Maximum Likelihood method. For the trip distribution model, attraction and cost variables (number of hotels, distance from origin to destination) were chosen together with specific attributes linked to the region of destination.

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\(^1\) The model was estimated using SPSS software and validated with several statistic tests.
Average temperature and precipitation were used to build the choice of month model, which was calibrated separately for each region, because of the different types of tourism, by using statistical data on hotel arrivals. The latter models (choice of day and of period) separate outward from return journeys and use variables linked to the particular day of the week and to the date of the month. The diagram in Figure 1 shows the result of the departure day model applied to the month of August 2001: peaks are on Friday and Saturday for outward journeys, whereas are on Sunday and Monday, for return journeys.

![Figure 1. Choice Percentages of departure day model](image)

The choice of period model within day also takes into account the day of the week and refers to three periods: morning (6 AM – 2 PM), afternoon / evening (2 PM – 10 PM) and night (10 PM – 6 AM). The model chain gives a series of OD matrixes containing the number of holiday trips with hotel and boarding house accommodation, divided according to month, day and hour of departure. It should be noted that for each period (8 hours) we have two OD matrixes (outward and return journeys), therefore the sum is necessary to obtain the total demand.

3 THE MODELLING OF DAY TRIPS AND THE CALIBRATION OF THE GLOBAL MODEL

In order to estimate those trips which cannot be deduced from available statistical data, such as day trips and trips to holiday accommodations owned or rented by travellers, a further model was built, calibrated with traffic flow data on particular links of the Italian motorways.

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2 Both models were calibrated by means of data provided by Società Autostrade S.p.A.
It was therefore necessary to set up a national network and an assignment model\(^3\). This particular demand was then estimated “by difference”, comparing assignment results with the observed traffic flow data, provided by motorway concessionaires. The scheme of the overall procedure, which comprises the models for both hotels and day trips, is shown in Figure 2.

The following relation has been used to express the global travel demand \( T(O,D) \):

\[
T(O,D) = a \, T_{\text{Hotel}}(O,D) + b \, R(O,D) / d(O,D)^n
\]

Being \( T_{\text{Hotel}}(O,D) \) the “basic hotel trips”, \( d(O,D) \) the distance from the origin \( O \) and the destination \( D \) of the journey; \( a \), \( b \) and \( n \) parameters to be calibrated. The values of \( R(O,D) \) were calculated by means of a heuristic formula which establishes the intensity of the tourist relationship between the zones \( O \) and \( D \). For all zones a conventional value has been attributed for each of the four chosen tourist types (sea, hill, mountain, art) to express the typical aptitude of the zone. The maximum value gives the prevalent type of the zone and the sum of the four values expresses how important the zone is for all features as a whole. Finally, if the type of both the zones \( O \) and \( D \) is the same, an “auto-attraction” factor decreases the value of \( R(O,D) \).

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\(^3\) The assignment model (S.U.E. Probit) was run using MT-Model, a C.S.S.T. software.
The coefficients of the new global model ("hotel trips" plus "day trips") were estimated using the Least Square method which aims to minimise the “distance” between the observed link flows and the simulated ones, obtained by multiplying $T(O,D)$ by the assignment matrix\(^4\).

4 CASE STUDY AND CONCLUSIONS

The application of the model focuses on the North-West of Italy during the month of August, which is quite interesting with regard to recreational trip studies. The network is composed of 102 nodes and 260 links, and comprises all existing motorways and several major roads; centroid nodes are the main towns for each region. The whole model was

\(^4\) It is a matrix which contains the percentages of the demand flows for each link of the network.
estimated for Sunday, August 7th 2001, in the morning period (6.00 AM – 2.00 PM). Then its ability to make accurate predictions was tested for the following Sunday, comparing the results of the assignment with the real traffic flows. The simulation shows that the model is able to predict tourist traffic with a reasonable degree of accuracy (the average difference is about 15%).

The aim was to model tourist trips and also to calibrate the global model using traffic flow data, which are affected by both tourist and systematic trips (typically home – work). Sunday was then chosen because systematic trips can be assumed negligible.

The study has shown that it is possible to build a complex non-work travel demand model from fairly simple tools, using statistical data and classic modelling structures. The cyclic procedure (assignment/calibration) was essential, since we were working in a congested network. Therefore assigning only a part of the total demand, during the first step, would have lead to an incorrect estimation of the model, because of non reliable path building.

The demand matrices estimated by means of this model can also be used as the reference demand by dynamic models, to simulate the pattern of traffic in continuous timing and the forecasting of traffic congestion progress. To develop this study further it might also be of interest to test the model during weekdays, in order to investigate the interaction between day-to-day journeys and non-work trip models. Finally a system of statistical survey (direct interviews) could be implemented to ascertain whether it would be possible to create direct demand models without passing through assignment models.
REFERENCES


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