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An application of activity-based travel analysis to simulation of home-study trips

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Abstract

A behavioural analysis is presented of individual decisions to participate in discretionary activities outside the home, in relation to the duration of that individual's dominant activities carried out (in or outside the home) before and/or jointly with the same discretionary activities and to other variables describing the individual's programme of activities, the characteristics of the supply of transport and the social and economic condition of the individual and his/her family.

The data used in the analysis come from a survey of the programmes of daily activity of Cagliari University students, the authors having determined, in a previous study, that in Italy university study can be classified as semidiscretionary, in the sense that it is a dominant but very flexible activity.

The first analyses of the university students' programmes of activity, using only linear regressions, show the interdependence of discretionary activities and the time devoted to study (at home, outside the home, at the university, elsewhere) and the structural relationships between these activities and their respective specific external variables.

1. Introduction

This study is a continuation of the work described at the First International Conference on Urban Transport and the Environment. Its aim is to identify the principal factors that influence the decision by university students to take part in discretionary activities during the course of the day, in relation to their types of programme of activity.

Travel for university study is of interest as a typical semidiscretionary activity, and in the city of Cagliari is also of considerable quantitative importance. In fact there are over 37,000 students enrolled with Cagliari University, most of whom gravitate towards the central part of the city where almost all the university buildings, shops, offices and municipal and regional administration are concentrated. University students make an average of 1.8 trips a day for university reasons alone [7,9] for a total of 67,000 trips per day

(1996 data) of which 40% by private car. Even though these figures do not include trips by students for non-university purposes, they still account for 23% of all trips in Cagliari city.

As already said, university study can be classified as a semidiscretionary activity since, although study is certainly the main commitment around which other purely discretionary activities (shopping, sports, leisure etc.) are organised, it is not a binding commitment but a constraint, that is a constraint that is accepted by the student (the student can sit for exams without the course lectures, so that the university activities are a constraint only if the student decides to attend). The second discretionary element arises from the timing of the lectures, which in turn decides the timing of the trips, which therefore varies from student to student during the course of the day and also from day to day for the same student.

Trips by university students therefore influence and increase the fraction of trips classified as "discretionary" and "semidiscretionary", which in recent years has reached extremely high levels and correspondingly high complexity, especially in the urban environment.

This great variability in trips towards the university not only directly influences the number and type of trips undertaken but also imposes less constraints on the organisation of other student activities, those which are purely discretionary. Obviously, the weaker the constraints imposed by the primary or dominant activity (which in this case is semidiscretionary), the wider the opportunities for organising personal programmes of activity.

The university student therefore seems to provide a typical example of movement resulting from semidiscretionary activity. For this reason it should be possible to generalise the results from a study of students' discretionary activities to all categories of individuals whose primary activity is semidiscretionary.

2. The activity-based approach for study of discretionary activities

The study is based on many others conducted in all parts of the world which show that the making of a trip results from the need to take part in activities in different places and that the characteristics of the trip (that is, the modalities by which it is made), depend not only on transport, or territorial, or socio-economic factors, but also on the so-called programme of activity carried out by the individual.

For example, it has been shown that the choice of transport mode is influenced by the programme of activity, since it may be more convenient to use one mode rather than another, depending on the programme of movements the individual must make to carry out the various activities [5].

Study of these phenomena is carried out using an approach known as activity-based, according to which the planning of the trips that an individual intends to make in the course of a certain time span (usually one day) must be based on knowledge and analysis of the same individual's programme of activity. Modelling is therefore extended to the whole set of trips and activities, rather than the single trip alone.

Study and especially modelling of such phenomena present different orders of difficulty arising from the widening of the time frame used to delimit the phenomenon studied, from the need to introduce aspects of the economic theory of maximisation of

utility in simulation of generative decisions, and from the number of direct and indirect factors that influence these decisions (direct factors are directly linked to the person making the decision; indirect factors are the result of decisions by others not covered by the study). Since the trip is no longer analysed as a circumscribed unit, but as a component of the so-called programme of daily - or better still weekly - activity, influenced by family characteristics, habits, and family, space and time constraints exerted by the environment, it is obvious that simulation models grow complicated and it becomes almost impossible to define all the possible cases within a single structure.

However, various modelling techniques have been developed: global, sequential and partial. The first aims to represent the programme of activity in its entirety, creating all the relationships involved. It therefore stimulates contemporaneously all the trips in a sequence (trip tour) or the entire sequence of trips during the day (travel pattern). If one takes this approach and simulates the entire sequence of trips during the day, the number of alternative decisions becomes great and their explication burdensome [1].

The second approach simulates the programme of trips or activities as a sequence of separate decisions, while taking account of the overall programme of the trips or movements or activities [3]. Partial models describe some important aspects of the programme, such as the choice or duration of some specific activities [2,4,6] and participation in discretionary activities during or after work, at home and/or outside the home.

Simulation of participation in discretionary activities once again requires a decision on what one wants to simulate: the decision on whether or not to participate in a given discretionary activity outside the home if this involves a trip, otherwise not; the decision to participate starting the trip from the home or from the workplace, which will obviously be a function of the occupational category; the decision to participate in a single activity or to create a chain of trips, linked or not with that for work; the period in which to make or not to make the trip; in the case of workers, the discretionary activity may be performed before going to work, when work has ended, during working hours, or after return home.

These decisions have been shown to be influenced (to a greater or lesser extent) by the type of discretionary activity the individual wants to pursue, by the total time spent on each activity, by the time spent in travel for obligatory activities and on returning home, which, in turn, is a function of the location of the activities, of the transport mode, route and time of departure [4]. In this area [6] examines the relationship between each individual's travel time to work and the decision to participate in discretionary activities. He starts from the idea that each individual has a given time budget that can be allocated to trips to carry out different activities during the day, and that those who spend more time on commuter travel are less likely to allocate additional time to participate in discretionary activities. On the other hand from [11], if participation is determined more definitely by the needs or desires of the individual and if overall the time constraints for activities outside the home are in general not fixed, one could expect no relationship between the length of the commuter trip and discretionary activities.

The results of Kitamura's studies show that duration of work is the most significant variable, while travel-time-to-work does not seem to influence participation in discretionary activities or the time devoted to them. This suggests that the worker's

decision to participate in discretionary activities is the result of powerful desires or needs and is not significantly influenced by the total travel time budget.

Most studies have been of employees and simulate the decision to participate in discretionary activities in various periods of the day more or less linked to work activity. In this study we have analysed the participation in discretionary activities of individuals who are not employees and perform an activity or work which is predominantly of what has been called the "semidiscretionary" type.

3. Application

The data used in the analyses that follow were collected during the 1995-96 academic year from daily activity records distributed to students at university premises, which they were asked to compile on the Tuesday of the following week. Since the records were collected at university premises, the collection day (Thursday) was made different from the day on which the students were asked to complete the form (Tuesday) so as to avoid having a sample composed only of students who had made the trip to the university.

The daily activity record is substantially the same as that used in the previous study [10]. In this survey, unlike the previous one, the questionnaire was distributed not only to the student but also to all the members of the student's family. In the case of students living away from home (living temporarily in Cagliari to study [8]), the questionnaire was distributed to all the people with whom the student was living during the period of study (friends or brothers/sisters, for the most part also university students).

The application described was aimed at identifying the principal factors that influence participation in discretionary activities outside the home in the case of individuals whose dominant activity is semidiscretionary. The time span examined was the 12 hour "working day" from 08.00 to 20.00 hours. All activities performed after 20.00 hours, most of them discretionary, were therefore excluded from the analysis. This decision was taken for two reasons: first, because the working day is the period that presents most problems for mobility in the urban environment, and secondly because we wanted to examine the extent and organisation of discretionary activities during the working day.

The analysis revealed a number of variables whose influence on the time dedicated to discretionary activities was tested in regression analysis.

Table 1 lists the variables tested and their coding, while Table 2 shows the results of fitting some curves obtained using the whole sample. Figures 1.1 and 1.2, show quite conspicuous differences in the behaviour of students living at home or away from home.

The results in Table 2 seem to show the decisive roles of car use and of the family for students living at home. In fact the variable CARPAT has been coded as the ratio between the number of cars in the family and the number of drivers in the family for students who live at home and as the ratio between the number of cars owned (by the student and his/her friends) in the dwelling and the number of drivers living there in the case of students living away from home. This variable is therefore an indicator of car availability in relation to the characteristics of the people with whom the student lives (the family for the student living at home, fellow-lodgers for those away from home).

Car availability turns out to be one of the most significant variables. It seems

that the time the individual devotes to discretionary activities - and perhaps the possibility of participating in them - increase with car availability. The effect of this variable differs between students living away from home (coeff.=-0.44 not significant at α=0.10) or at home (coeff.=+2.09 significant at α=0.05).

On the role of the family, implicitly incorporated in the variable CARPAT, it should be emphasised that the constraint on the parents, encountered in many studies, does not seem to apply to the offspring, whose activities seem to be fairly independent within the family. The only constraint that seems to unite the student to the family is use of the car. In fact about 93% of the students interviewed had a driving licence, whereas only 48% said they owned a car. Of students living away from home, only 21% had a car available to them in the place where they were studying ("available" in this case means belonging to the student or to a fellow lodger). In contrast, about 92% of the students living at home said they had a car; bearing in mind that the ratio of cars to drivers in the family for this category of students is 0.67, interdependence between family members becomes obvious.

The time dedicated to discretionary activities outside the home seems to be independent of the time dedicated to semidiscretionary activities both at home and outside the home. The coefficient of the variable TIMEACTIVITY (sum of time dedicated to study at home or at other students homes plus time spent at the university) is not significant at =0.10. Even when the time spent in study outside the home, at the university or at another student's home (which requires travel) is separated from the time devoted to study at home, the result is practically the same.

In contrast to what has been found for non-discretionary activity (paid employment) in which the length of time worked [6] seems to be the factor with greatest influence on participation in discretionary activities, in this case length of time spent studying seems to be without influence. Probably, the breaking up of the work activity when it is semidiscretionary makes the duration of discretionary activity independent of that of the semidiscretionary one.

The time spent in travel, TIMETRIP, also seems to have no influence on the duration of participation in discretionary activities, a result which agrees with those of many other authors. Separation into travel time for discretionary and for semidiscretionary activities does not alter the level of significance.

On the other hand, the personal characteristics of the student SEX and AGE seem to be very important, as has been shown in many other studies. The level of significance for both coefficients reaches =0.05. Since these variables have been codified as dummy variables (1=male; 0=female; 1 for students over 24 years of age, 0 for students under 24) the results show that males travel more than females, an expected result, since it has been found in many other studies, and that the older the age the greater the propensity to participate in discretionary activities. This last result seems reasonable in the light of the fact that students aged 24 or over have taken more than the minimum number of years required to graduate.

Finally the variable representing the time of arrival HARRIVE (codified as a binary "1" if the first trip to the university is made before 08.30 and "0" if made after 08.30) suggests that the earlier the first trip is made the more time remains for discretionary activities, though the level of significance is not high.

Conclusions

The study has shown that participation in discretionary activities, and especially the duration of participation, is greatly influenced by the availability of a car to the university student and that this availability, in turn, depends on whether the student is living with his/her family and on the characteristics of the latter. This result is certainly of general validity. In contrast, the duration of discretionary activities seems to be independent of participation in and the duration of semidiscretionary activities, and also of the time spent travelling. Although other studies have produced the same results, we do not feel that they can be extended to all categories of semidiscretionary activities. The lightness of the constraints bearing on the students and their lesser need to meet certain requirements may have influenced this result.

Our research is already aiming in the direction of extending the category in which the dominant activity is semidiscretionary, with the aim of confirming the results already obtained and finding others for behaviours not encountered among university students. In addition, in the field of modelling, we are studying the idea of joint simulation of the choice of discretionary activity and the time allotted to it.

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Table 1 - Variables used in the analisy

Variables	*Code*
CARPAT	Number of cars available divided by number of drivers in the house
SEX	Binary variable: 1 male, 0 female
AGE	Binary variable: 1 if the student is yonger than 24, 0 otherwise
COMPINCOME	Number of members in the houshold who have income divided by number of members in the houshold
HARRIVE	Binary variable: 1 if the student arrived at the University, on his first trip, before 8:30 am, 0 otherwise
DURATION1U	In hours. Duration of the first activity at University
TIMEHD	In hours. Time spent at home for discretionary activities between 8:00 am - 8:00 pm
TIMECAR	In hours. The whole time spent in the car between 8:00 am - 8:00 pm
TIMEBUS	In hours. The whole time spent in the bus between 8:00 am - 8:00 pm
TIMEWALK	In hours. The whole time spent walking between 8:00 am - 8:00 pm
NSPCAR20	Number of trips by car after 8:00 pm (only discretionary activities)
UNIVCAR	In hours. The whole time spent in the car going to the University between 8:00 am-8:00 pm
UNIVBUS	In hours. The whole time spent in the bus going to the University between 8:00 am-8:00 pm
UNIVWALK	In hours. The whole time spent walking to the University between 8:00 am - 8:00 pm
COLLEGCAR	In hours. The whole time spent in the car going to colleg's house between 8:00 am - 8:00 pm
COLLEGBUS	In hours. The whole time spent in the bus going to colleg's house between 8:00 am - 8:00 pm
COLLEGWALK	In hours. The whole time spent walking going to colleg's house between 8:00 am - 8:00 pm
DACTIVCAR	In hours. The whole time spent in the car to take part in discretionary activities between 8:00 am - 8:00 pm
DACTIVBUS	In hours. The whole time spent in the bus to partecipate in discretionary activities between 8:00 am - 8:00 pm
DACTIVWALK	In hours. The whole time spent walking to partecipate in discretionary activities between 8:00 am - 8:00 pm
NACTIVM	Number of discretionary activities in the morning
NACTIVE	Number of discretionary activities in the evening
NSTUDM	Number of activities at the University in the morning
NSTUDEE	Number of activities at the University in the evening
TIMETRIP	In hours. It means all time spent in trips (all modes) between 8:00 am - 8:00 pm
TIMEACTIVITY	In hours. It means all time spent in activities (all type) between 8:00 am - 8:00 pm

Table 2- Estimated coefficients (all sample)

Variable	*Coefficient*	*t-ratio*
CARPAT	0.601	2.153
SEX	0.615	2.222
AGE	0.464	1.930
TIMETRIP	- 0163	- 0.577
TIMEACTIVITY	- 052	- 1.139
HARRIVE	0.215	0.627

N obs = 77
$R^2 = 0.99$
Adjusted $R^2 = 0.99$
Log-Likelihood = -115.42
Log-Likelihood ($\beta = 0$) = -539.76

Fig.1.1 Scheme of different acitvity programs - "IN SEDE" students

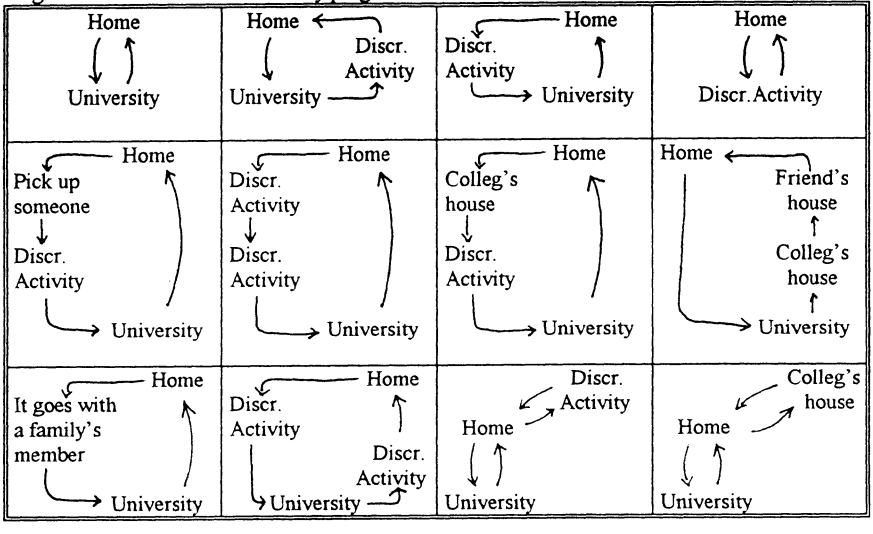


Fig.1.2 Scheme of different acitvity programs - "FUORI SEDE" students

