The access/egress mode choice to railway terminals

Umberto Crisalli & Francesca Gangemi
Department of Civil Engineering, «Tor Vergata» University of Rome, via di Tor Vergata snc, 00133 Rome, Italy
EMail: crisalli@mingus.civ.utovrm.it

Abstract

In this paper the analysis and the simulation of the access/egress mode choice for railway terminals for extraurban medium-long distances trips have been considered. Some descriptive analyses have been carried out depending on trip purpose (work, business, study, other), family income (medium-high, low), possibility of trip cost refundation, possibility of car availability, type of origin/destination place (metropolitan area, big town, small-medium town). In the case of access/egress terminals located in an urban area different from the origin one, nested-logit models have been carried out for different trip purposes, considering level of service attributes and users' characteristics.

1. Introduction

Access/egress disutility plays a fundamental role in the choice of trip primary mode (car, bus, train, plane) in extraurban trips; for this reason, in the latest years a greater attention has been focused to the analysis and simulation of this trip component (Russo^, Nuzzolo&Russo®).

Some works which use behavioural choice models are the ones of Chu & Imada^, Chu et alii^, Mukundan^, Particularly, Chu et alii^ calibrated a choice model of access and egress modes related to a suburban railway station and Mukundan^ calibrated a nested logit model for the joined choice of access mode and access station related to the urban railway system of Washington DC.

This paper aims to analyse and simulate the access/egress mode choice to railway terminals for medium-long distance extraurban trips. Such an activity has been carried out within the implementation of a Decision Support System aimed to modelling the impacts of changes in railway fares and services,
developed by FS Italian Railways, as described in the following.

In the first part of the paper, the general structure of the DSS is shortly described and a general analysis of the access/egress modes used by the users of the Turin-Venice railway corridor is reported; in the second part a nested logit model for the simulation of the access/egress mode choice is reported.

2. The DSS general structure model

In the DSS (named SASM, that is System of Analysis and Simulation for operational Marketing, Sintra\textsuperscript{10}) the user’s choices in extraurban context are simulated and they regard: primary mode (car, bus, plane, fast train, slow train, night train), service and/or class when it concerns a multiservice mode with several comfort classes, run to be used, access/egress terminals, access/egress modes to terminals.

The behavioural model used to simulate such a decisional process is a tree-logit type (Ben Akiva & Lerman\textsuperscript{1}; Daganzo & Kunsic\textsuperscript{5}) and it is based on the random utility theory. It allows to simulate the existing covariance among alternative’s sets which share a set of attributes that the user perceives in “similar” mode (figure 1).

Because of general model complexity, at the moment a tree-logit model related to the railway services has been calibrated (Cascetta\textsuperscript{7}), in which railway service, run and class choices are simulated (figure 2). As regards the attributes of access/egress modes, distances are actually used as proxy of access/egress disutilities. Actually analysis and modelling of the access/egress choice model, whose first results are this paper’s aim, are in progress. Through the obtained models, the inclusive utility of access/egress choices inside the general choice model for railway services will be used and then it will be possible to calibrate some models with a further level to simulate access/egress choices.
3. The used demand database

For the analysis and calibration of choice models of access/egress mode to railway terminals, a data base related to a on-board train survey on the Turin-Venice railway corridor, carried out by FS Italian Railways, has been used. It regards: counts of passengers (approx. 50,000) boarding Intercity, Express, Interregional and Regional trains on a working day, with interviews on origins and destinations; survey of a sample of about 10,000 users, with questions regarding terminals used, access and egress mode, trip purpose, target time and socio-economic characteristics. In particular they were asked: age, sex, habitual residential district, family role, family components number, educational level, professional position, income, number of cars in family, driving licence possess and car availability for the trip.

4. General analysis results

Generally, talking about access modality we refer to all users available alternatives modes to reach the departure terminal of primary mode (where primary mode means used mode for most trip); on the contrary talking of egress modality we refer to users available alternative modes to reach the destination from the egress terminal of primary mode.

We recognize as choice alternatives set for access/egress mode, respectively

\[ I(\text{access}) = \{\text{Fed}, \text{L&R}, \text{P&R}, \text{Tr}, \text{Taxi}\]  
\[ I(\text{egress}) = \{\text{Fed}, \text{L&R}, \text{Tr}, \text{Taxi}\] where:

Ped = Pedestrian; L&R = Left&Ride (for example Kiss&Ride); P&R=Park&Ride; Tr = Transit; Taxi = Taxi.

The analysis has been carried out considering four trip purposes: Work, Business, Study, Other, distinguishing Home in origin from Home in destination. It remarks the existence of a symmetry between the access for on going trips and the egress for return trips and vice versa (Figure 3). In this context, on the behavioural point of view, «Access» is defined to be the home-to-terminal trip (for the on going trip) and the terminal-to-home trip (for the
return trip) (Table 1). Similarly, «Egress» is defined to be the terminal-to-destination trip (for the on going trip) and the destination-to-terminal trip (for the return trip) (Table 2).

### Table 1: «Access» mode distribution

<table>
<thead>
<tr>
<th></th>
<th>Work</th>
<th>Business</th>
<th>Study</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on going</td>
<td>egress</td>
<td>on going</td>
<td>egress</td>
</tr>
<tr>
<td>Ped</td>
<td>16%</td>
<td>20%</td>
<td>14%</td>
<td>16%</td>
</tr>
<tr>
<td>L&amp;R</td>
<td>7%</td>
<td>12%</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>P&amp;R</td>
<td>39%</td>
<td>32%</td>
<td>31%</td>
<td>25%</td>
</tr>
<tr>
<td>Tr</td>
<td>22%</td>
<td>22%</td>
<td>26%</td>
<td>29%</td>
</tr>
<tr>
<td>Taxi</td>
<td>1%</td>
<td>1%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>14%</td>
<td>13%</td>
<td>11%</td>
<td>14%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Table 2: «Egress» mode distribution

<table>
<thead>
<tr>
<th></th>
<th>Work</th>
<th>Business</th>
<th>Study</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>access</td>
<td>egress</td>
<td>access</td>
<td>egress</td>
</tr>
<tr>
<td>Ped</td>
<td>45%</td>
<td>41%</td>
<td>22%</td>
<td>39%</td>
</tr>
<tr>
<td>L&amp;R</td>
<td>2%</td>
<td>3%</td>
<td>11%</td>
<td>9%</td>
</tr>
<tr>
<td>Tr</td>
<td>43%</td>
<td>47%</td>
<td>49%</td>
<td>37%</td>
</tr>
<tr>
<td>Taxi</td>
<td>1%</td>
<td>1%</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>8%</td>
<td>8%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Figure 3: «Access»/«Egress» in on going and return trips
Origins and destinations have been divided in four categories:

- Metropolitan areas: Milan, Turin, Genoa, Rome, Naples, Palermo;
- Big towns: towns with more than 150,000 inhabitants;
- Medium towns: towns with a population between 20,000 and 150,000 inhabitants;
- Small towns: towns with less than 20,000 inhabitants;

as town dimension may influence the choice for the reason that bigger towns has generally greater supply of services (think of the subway or other transit services) so to increase the use of transit.

Furthermore five different users categories have been considered:

- reimbursed (cat. 1);
- not reimbursed with low income (family income less than 40 millions ITL a year) and with car availability (cat. 2);
- not reimbursed with low income and no car availability (cat. 3);
- not reimbursed with medium-high income (family income more than 40 millions ITL a year) and with car availability (cat. 4);
- not reimbursed with medium-high income and no car availability (cat. 5);

To take into account the different transit supply for «Access»/«Egress» trips inside the same urban area and the ones among different urban area, we carried out a differentiated analysis.

4.1 The «Access»/«Egress» mode distribution inside the same urban area

From the analysis of «Access»/«Egress» mode distribution we find out:

- the percentage concerning transit tends to increase when town dimensions increase independently from trip purpose both for «Access» and for «Egress» (from 20-30% to 40-50%) (figures 4 -7);
- the percentage concerning Park&Ride is predominant for work and business purposes and increases in small and medium towns to the detriment of transit mode (figures 5, 7);
- the share of «Egress» pedestrian mode is about 30% (with a 42% peak for Work purpose) considering Metropolitan area and big town, while for medium and small towns the share is about 40% with a 63% peak for Work purpose;
- for study purpose the share of pedestrian trips (about 38%) and of transit (about 30%) is constant both for the «Access» and the «Egress» and it is independent from town type;
- Left&Ride choice is quite constant (5-10%) independently from town dimension and trip purpose and even user’s categories(figure 8);
- Taxi alternative choice results significant only for Business purpose and for reimbursed users and then it increases when town dimensions increase where the supply of such a service increases;
- the pedestrian and transit alternative choice is greater for users
categories with no car availability, as aspected.

Figure 4: «Access» mode distribution in Metropolitan Area and Big Town.

Figure 5: «Access» mode distribution in Medium and Small Town.

Figure 6: «Egress» mode distribution in Metropolitan Area and Big Town.
4.2 The «Access» mode distribution with the terminal belonging to a different urban area from the origin trip one

We notice that it was not possible to carry out the «Egress» analysis, we have only a few available interview, as the user prefers, if he can afford it, to use private transport or possible direct links on bus when the terminal of railway services belongs to a different urban area from the origin trip one.

From the comparison with results obtained for terminal belonging to the same urban area we can observe:

- the percentage relative to car (both P&R, L&R) increases and the percentage relative to transit decreases for work, business and other purpose and even for reimbursed categories, while for study purpose the percentage relative to transit increases from 33 to 45%;
- the percentage of users not reimbursed with low income, that chooses mode P&R decreases from 60% to 30% (Figures 4,5,8);
- the percentage of users that choose L&R decreases from 20% to 10%
In the following, the results of specification and calibration of a nested-logit model for the access mode choice are reported; the access is relative to terminals belonging to a different urban area from the origin one. Here below we report the utility functions for each alternative:

$$V_{L&R} = \beta_1 T_{L&R} + \beta_2 C_{L&R} + \beta_7 L&P \& R$$

$$V_{P&R} = \beta_1 T_{P&R} + \beta_2 C_{P&R} + \beta_3 \text{Inc}_\text{mh} + \beta_5 \text{Comp}$$

$$V_{Tr} = \beta_1 T_{Tr} + \beta_2 C_{Tr} + \beta_4 \text{Trm}_\text{type} + \beta_6 \text{Tr}$$

where:

- \( j \) = P&R, L&R, Tr;
- \( T_j \) = "Access" time mode J[h];
- \( C_j \) = monetary cost for mode J [ITL*1000];
- \( \text{Inc}_\text{mh} \) is a dummy variable that is equal to one if the user has a medium-high income, zero otherwise;
- \( \text{Trm}_\text{type} \) is a dummy variable equal to one if the terminal belongs to a
Urban Transport and the Environment for the 21st Century

Metropolitan area or to a big town, zero otherwise;

Comp is a dummy variable equal to one if the users travel accompanied, zero otherwise;

Tr is a dummy variable equal to one in utility function related to Transit, zero otherwise;

L&R is a dummy variable equal to one in utility function related to Left&Ride, zero otherwise.

Furthermore the car alternative is available only if the family car number is more than zero, and the alternative P&R is available only if the user is licensed and has an available car; from the analysis the Taxi alternative results little used and then it is excluded from choice model.

Model is calibrated for four different purposes: work, business, study, other and results are reported in table 3; we can observe that all coefficients have correct signs and most are statistically significant. Moreover the value of time (VOT) is strictly linked with trip purpose, in fact people who travel for business or other purposes is willing to pay more than the double respect to people who travel for systematic purpose (as work). Then we note, that for study purpose time is not a perceived attribute, while great importance is given to trip monetary cost.

<table>
<thead>
<tr>
<th></th>
<th>Work</th>
<th>Business</th>
<th>Study</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \beta )</td>
<td>( t ) ratio</td>
<td>( \beta )</td>
<td>( t ) ratio</td>
</tr>
<tr>
<td>Time</td>
<td>-4.83</td>
<td>(-2.71)</td>
<td>-4.30</td>
<td>(-1.75)</td>
</tr>
<tr>
<td>Cost</td>
<td>-1.11</td>
<td>(-3.35)</td>
<td>-0.40</td>
<td>(-1.28)</td>
</tr>
<tr>
<td>Inc_mh</td>
<td>1.06</td>
<td>(1.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trm_type</td>
<td>0.75</td>
<td>(1.87)</td>
<td>0.41</td>
<td>(0.68)</td>
</tr>
<tr>
<td>Comp</td>
<td></td>
<td></td>
<td>1.04</td>
<td>(3.07)</td>
</tr>
<tr>
<td>Tr</td>
<td>2.16</td>
<td>(2.12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L&amp;R</td>
<td>-1.68</td>
<td>(-4.05)</td>
<td>-1.77</td>
<td>(-5.14)</td>
</tr>
<tr>
<td>( \theta ) _car</td>
<td>0.33</td>
<td>(5.20)</td>
<td>0.70</td>
<td>(0.93)</td>
</tr>
<tr>
<td>( \rho^2 )</td>
<td>0.31</td>
<td></td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>VOT (IT£)</td>
<td>4350</td>
<td></td>
<td>10750</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Calibration results
References