A DEMAND MODEL SYSTEM
FOR EXTRA URBAN SHOPPING TRIPS

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Summary

✓ Introduction

✓ Study area
  ➢ Spatial pattern
  ➢ Zoning

✓ Survey
  ➢ The dataset
  ➢ Mobility and transport characteristics

✓ The demand models system
  ➢ Trip generation
  ➢ Trip distribution
  ➢ Mode choice

✓ Conclusions
Introduction

Travel choices

✓ Shopping is a major cause of travel, as it forms part of the lifestyle of the population.

✓ Shimazaki et al. (1994) mention that shopping is the second most frequent type of urban travel.

✓ In the United Kingdom (UK), shopping related trips account for about 20% of car travel (Department of Transport, Local Government and the Region 2001).
Introduction

✓ Most of the current travel literature focuses on studying the characteristics of worker trips.

✓ Little emphasis has been placed on studying non-worker travel patterns, e.g. shopping trips

✓ Some shopping facilities are in extra urban locations

What are the factors that affect the extra-urban shopping trips?
Introduction

State-of-the-art

✓ Trip generation

➢ Mainly affected by socio-economic characteristics of the trip makers and the land-use pattern and developments in the study area (or the physical characteristics of the area): Levinson (1976), Koppelman and Pas (1984), Bruton (1986), Pas (1986), Cobukcu (2001), Yao et al. (2008), Cao et al. (2010), Gonzalez-Feliu et al. (2010)

✓ Trip distribution

Introduction

State-of-the-art

✓ Modal split

➤ there is little understanding of shoppers’ attitudes towards the various transport modes for shopping purposes (Recker and Stevens 1976; Williams 1978; Cervero 1996; Bhat 1998).

➤ **Not much research** has been attempted to investigate perceptions of the various modes of transportation for shopping trips.

➤ Some researchers propose to model jointly

  ❑ destination and mode choices, Vrtic et al. (2007)

  ❑ mode and departure choices, Bhat (1998)
Introduction

Objectives

✓ Identification of different factors affecting shopping:

➢ Socio-economic characteristics such as: income, gender, employment status and household size.

➢ Physical and demographic characteristics of area, such as: employment, population and density.
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Study area

Provinces of Messina and Reggio Calabria

✓ 6,320 km²
Study area

Spatial pattern

✓ 1,220,714 inhabitants (2010)
Study area

Spatial pattern

✓ 433,660 employees
Study area

Provinces of Messina and Reggio Calabria

✓ 58,428 retailers
Study area

Zoning

✓ **Level 1:** Reggio Calabria and Messina provinces, excluding Reggio Calabria and Messina municipalities, are divided in traffic zones on municipality basis (each traffic zone is defined by one or by an aggregation of different municipalities, using a level of detail which increases with the closeness to the chief provincial town);

✓ **Level 2:** Reggio Calabria and Messina municipalities are divided in traffic zones on the basis of census data (each traffic zone is defined by one or by an aggregation of different census zones)

✓ The total number of traffic zone is **56:**
  - 35 relative to level 1 zoning;
  - 21 relative to level 2 zoning (13 for Reggio Calabria and 8 for Messina).
Study area

Zoning

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Surveys

Telephone interviews to people living in Reggio Calabria and Messina districts aiming at investigating:

- socio-economic characteristics;
- Origin and Destination (O/D);
- trip purpose (work, study, shopping,…)
- frequency and characteristics of intra-municipality trips
- frequency and characteristics of extra-municipality trips
A) SEZIONE DATI FISSI

**Q1A**
In quale comune è domiciliato? → DA TELEFONICO

Reggio Calabria → passare a Q.8
Messina → passare a Q.8
QUOTE
Villa S. Giovanni → passare a Q.8

**Q1B**
Altri Comuni → ALTRI (COME DA Q.A, COD DA 1 A 3)

**Q2**
In quale via è domiciliato? (è necessaria) è codice via da inserire a Q.21

**Q3**
Quartiere ________________ → codice zona da inserire a Q.21

2: MANCATA RISPOSTA

**Q4**
REGISTRARE SESSO

1: Uomo
2: Donna

**Q5**
Quale è la sua età?

1: fino a 10 anni → CHIUDERE
2: 11-19 anni
3: 20-24 anni
4: 25-34 anni
5: 35-44 anni
6: 45-54 anni
7: 55-64 anni
8: 65 ed oltre → CHIUDERE

**Q6**
Da quanti componenti è costituita la sua famiglia, includendo lei? ___________ /n

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Survey Questionnaire

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Survey Dataset

Shopping trips within study area: 576 interviews
Survey

Mobility and transport characteristics

Weekly extra-urban shopping trips

[Bar chart showing the distribution of weekly shopping trips with the majority of respondents making 1 trip per week.]
Survey

Mobility and transport characteristics

Weekly extra-urban shopping trips
Survey

Mobility and transport characteristics

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Survey

Mobility and transport characteristics

Mode distribution of extra-urban shopping trip

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>95%</td>
</tr>
<tr>
<td>Bus</td>
<td>4%</td>
</tr>
<tr>
<td>Train</td>
<td>1%</td>
</tr>
</tbody>
</table>
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The demand models system

- The system of models is made of:
  - trip generation model
  - distribution model
  - mode choice model

\[
\text{Number of trips for passenger of category } i \text{ for origin } o \text{ and destination } d \text{ using mode } m = \text{Number of trips from origin } o \text{ made by passenger of category } i \cdot p^i[d/o] \cdot p^i[m/od]
\]

- Number of trips for passenger of category \( i \) for origin \( o \) and destination \( d \) using mode \( m \)
- Number of trips from origin \( o \) made by passenger of category \( i \)
- The probability of using mode \( m \) for passenger of category \( i \) departing from origin \( o \) to destination \( d \)
- Probability that passenger of category \( i \) departing from origin \( o \) arrives at destination \( d \)
The demand models system

Trip generation model

\[ d_{i,o} = n_{i(o)} \cdot m^i \]

where:

✓ \( d_{i,o} \) is the average number of extra-urban trips made by passengers of category \( i \) living in zone \( o \);

✓ \( n_{i(o)} \) is the number of passengers of category \( i \) living in zone \( o \);

✓ \( m^i \) is the average number extra-urban trips made by passengers of category \( i \).
The demand models system

Trip generation model

(≥ 1 weekly trip)

\[ m_i = 0.121 \cdot WM + 0.269 \cdot DL - 0.366 \cdot DRET + 1.116 \]

where:

- \( m_i \) is the number of weekly extra-urban shopping trips of passenger category \( i \);
- \( WM \) is a dummy variable equal to 1 if passenger is woman, 0 otherwise;
- \( DL \) is a dummy variable equal to 1 if passenger holds driving licence, 0 otherwise;
- \( DRET \) is the ratio of retail employees and inhabitants of given zone,

\( R^2 = 0.67 \)
The demand models system

Trip distribution model

\[ p^i [d / o] = \frac{\exp(V^i_{od})}{\sum_{d'} \exp(V^i_{od'})} \]

where \( V^i_{od} \) represents the systematic utility for destination \( d \) departing from origin \( o \), which is a linear combination of attributes of destination \( d \) (\( X^i_{k,od} \)):

\[ V^i_{od} = \sum_k \beta_k X^i_{k,od} \]

Attributes considered for the distribution simulation can be classified in cost attributes (depending on O/D pair) and attractivity ones (which depend exclusively on destination).
The demand models system

Trip distribution model

\[ V_d^i = 0.363 \ln(RET_d) - 1.747 \ln(T_{od}) - 4.301 \cdot OD + 1.457 \cdot RZONE \]

where:

- \( RET_d \) is the number of retail employees in zone \( d \);
- \( T_{od} \) is the travel time from \( o \) to \( d \) on the minimum generalised travel cost;
- \( OD \) is a dummy variable equal to 1 for intrazonal trips, 0 otherwise;
- \( RZONE \) is a dummy variable equal to 1 if zone \( d \) is a commercial zone, 0 otherwise.
The demand models system

Mode choice model

\[ p[m/od] = \frac{\exp(V_{m}^{od})}{\sum_{m'} \exp(V_{m'}^{od})} \]

where \( V_{m}^{od} \) is the systematic utility of the mode alternative \( m \), defined as linear function of attributes:

\[ V_{m}^{od} = \sum_{k} (\beta_{k} \cdot X_{k,m}^{od}) \]

with:

- \( X_{k,m}^{od} \) is the generic attribute \( k \) relative to mode \( m \) and O/D pair \( od \);
- \( \beta_{k} \) is the parameter estimated for attribute \( k \).
The demand models system

Mode choice model

\[ V_{\text{car}} = -0.171 \cdot T_{\text{car}}^{\text{od}} - 0.075 \cdot C_{\text{car}}^{\text{od}} + 0.1815 \cdot OD + 1.14 \cdot DLC \]

\[ V_{\text{bus}} = -0.171 \cdot T_{\text{bus}}^{\text{od}} - 0.075 \cdot C_{\text{bus}}^{\text{od}} - 2.187 \]

\[ V_{\text{train}} = -0.171 \cdot T_{\text{train}}^{\text{od}} - 0.075 \cdot C_{\text{train}}^{\text{od}} - 3.222 \]

✓ \( T_{m}^{\text{od}} \) is the travel time from \( o \) to \( d \) with mode \( m \) (hour);
✓ \( C_{m}^{\text{od}} \) is the travel cost from \( o \) to \( d \) with mode \( m \) (Euros);
✓ \( OD \) is a dummy variable equal to 1 for intrazonal trips, 0 otherwise;
✓ \( DLC \) is a dummy variable equal to 1 if passenger holds the driving licence, 0 otherwise

\[ \rho^2 = 0.80 \]
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✓ Conclusions
Conclusions

✓ A demand modelling system for extra-urban shopping trips has been specified and calibrated

✓ Further analyses are needed in order to

  ➢ Improve these first results
  ➢ Investigate how the trade characteristics of shop (retailer) location can influence the passengers’ choices
  ➢ Investigate how the characteristics of sold freight (e.g. trademark) can influence the passengers’ choices
  ➢ Investigate the role of purchasing zone accessibility
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