

SIDT Scientific Seminar 2013

A hybrid discrete choice model to assess the effect of awareness and attitude towards environmentally friendly travel modes

Eleonora Sottile^{a*}, Italo Meloni^b, Elisabetta Cherchi^c

^aUniversity of Cagliari - CRiMM, via San Giorgio 12, Cagliari 09124, Italy

^bUniversity of Cagliari - CRiMM, via San Giorgio 12, Cagliari 09124, Italy

^cTechnical University of Denmark - DTU, Bygningstorvet 116B, Lyngby 2800, Denmark

Abstract

The need to reduce private vehicle use has led to the development of soft measures aimed at re-educating car users through information processes that raise their awareness regarding the benefits of environmentally friendly modes, encouraging them to voluntarily change their mode choice behaviour (level-of-service characteristics being equal). It has been observed, though not scientifically demonstrated, that these measures can produce changes, being the result of mindful decisions. However, in some cases, as demonstrated by numerous environmental psychology studies such measures are not sufficient to overcome the effect of cognitive dissonance, one of the main factors hindering change. In fact it is not unusual to find discrepancies between attitudes and behaviour in travel behaviour research.

The objective of the present work is to understand the relationship between awareness, attitude and behaviour in the context of mode choice and to measure the effect of awareness after the implementation of a soft measure after controlling for individual environmental attitudes. Using a dataset gathered in two weeks, before and after individuals are informed of the benefits of using park and ride (P&R) instead of their car, we estimated a hybrid mode choice model.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the Società Italiana dei Docenti di Trasporti (SIDT).

Keywords: Attitude, Awareness, Behaviour, Environment, Soft measures

* Eleonora Sottile. Tel.: +39-070-675-6407; fax: + 39 070 675 5261.

E-mail address: elesottile@gmail.com

1. Introduction

Traffic is the main culprit of air pollution in urban areas, due to the emissions of the combustion products of fuels and their subsequent chemical transformation, as well to the evaporation of unburned hydrocarbons. In recent years, the objective of transport research has thus undergone a major shift towards methods aimed at reducing private vehicle emissions. Transport accounts for 25% of CO₂ emitted globally, mainly in industrialised countries, and road transport was responsible for 93% of all transport emissions in the EU-27 in 2008 and 86% of those in the U.S.A. (IEA, 2010; Schwanen *et al.*, 2011).

Several actions and measures have been developed to try to mitigate harmful emissions. These refer mostly to vehicles technology (more efficiency both in terms of consumption and production of polluting emissions), type of fuel (bio fuel, hydrogen, and electricity), economic tools and institutional controls (pricing policies, incentives, taxes, *etc.*) information and communication technologies (ICT). Although powerful, these measures have not proved to be sufficient to solve the problem.

The need to reduce car use has led to the development of soft measures, also referred to as "Voluntary Travel Behaviour Change" (VTBC) programmes (Ampt, 2003), aimed at re-educating car users through information processes that raise their awareness regarding the benefits of environmentally friendly modes, encouraging them to voluntarily change their mode choice (level-of-service characteristics being equal).

Soft measures are programmes aimed at motivating the voluntary reduction of car use. Under various names and forms, VTBC programmes have been implemented mainly at a personal and community level (as mass communication), especially in Australia, UK, Japan, Germany, and Austria (see *e.g.* Ritcher *et al.*, 2011). The models of mass communication are programmes that use mass media to influence public opinion highlighting the problems of congestion, pollution and indicating alternative sustainable modes of transportation (Rose and Ampt, 2003). This kind of communication is typically used for public transport information and marketing and for travel awareness campaigns (Jones and Sloman, 2003). As opposed to mass communication, the VTBC programmes, also defined as "Personalised Travel Planning" (PTP) aim to provide individuals and households with travel-related information based specifically on their daily activity-travel needs. The advantage of using a personalised approach instead of mass communication lies in the fact that tailored information directed to each single individual cannot be easily disregarded by the car-user (Gärling and Fujii, 2009).

IndiMark (TravelSmart) and Travel Blending are two PTP approaches. Both are targeted at individuals and households and are based on providing information on how to travel in a more sustainable way, reducing car use (Bonsall, 2007). IndiMark is a social marketing approach that tries to improve the knowledge of the transport system. It is an "individualised" programme because it is targeted at individuals, but not quite "customised" (Stopher, 2005) because participants are only asked whether they are interested in reducing car use and are then provided with a package of general information. This allows the programme to be implemented at the large scale. In fact in the first TravelSmart implementation in South Perth, Australia in 2000, more than 15,300 families were contacted and around 6,000 participated. After this, other projects have been carried out in various parts of the world including Sweden, Germany, UK, USA and other parts of Australia.

The Travel Blending approach instead aims to reduce the number of car journeys providing individuals with specific suggestions that consist of a "blend" of travel choices related to their specific activity patterns. Therefore it is a customised programme. Since the Travel Blending approach provides quantitative feedback customised to each individual trip, the scale is much smaller than in the Travel Smart programmes. The study carried out in Australia (Rose and Ampt, 2001; Richter *et al.*, 2011) with 1,000 households, is the largest. Studies conducted in Japan (Taniguchi *et al.*, 2003; Fujii and Taniguchi, 2005) use samples of around 200 households, while the work carried out in Nottingham and Leeds is based on a sample of roughly 100 households.

These studies assess the overall effectiveness of the programme comparing the number of car trips before and after the implementation of the soft measure. None of them analyses the specific leverage, among all the information provided, that led to behaviour change. Neither have they measured the relative importance of the soft measures compared to other improvements in the supply characteristics.

Moreover, information campaigns are based chiefly on providing information about the negative effects of choosing to use the private car, highlighting the benefits of more sustainable travel modes. Current research in the areas of public health, energy consumption, waste management and so forth has shown information campaigns to be ineffective in bringing about long-lasting changes in behaviour (Hines *et al.*, 1986/87; Hornik *et al.*, 1995). In this regard Tertoolen *et al.* (1998) observe the presence of cognitive dissonance *i.e.* inconsistency between attitudes and behaviour. This means that despite individuals attitude to behave for example in an environmentally friendly manner, their actual behaviour differs from the intended one.

Further, environmental behaviour has multidimensional conceptions. Particularly, in the transportation sector there appears to be moderate or little correlation between putting into practice different kinds of environmentally friendly behaviour. On the other hand sustainable behaviour such as the use of public transport is a case apart, probably because no single pro-environmental motivation exists for behaving in this way, likely the result of other kinds of motivation such as economic benefits, comfort, *etc.* (Bonnes *et al.*, 2006). One reason may be that people behave pro-environmentally only when it is easy to do so (Stern and Oskamp, 1987). Moreover, compensation in environmental behaviours might also exist such that environmental behaviour is a substitute rather than a complement. Environmental compensation could result if people with environmental preferences net their feelings of guilt for using the car with increased environmental behaviours in other areas of life, like composting and recycling (Johansson *et al.*, 2006).

In general, however, cognitive dissonance is psychologically unpleasant, and usually individuals try to reduce it. In the specific case studied in this work, a person can try to reduce cognitive dissonance either by reducing car use (behavioural change) or by changing attitude (*i.e.* having less negative attitudes) towards the undesirable effects of car use (Tertoolen *et al.*, 1998). Since soft measures are designed to increase car users' awareness of the environmental consequences related to their travel behaviour, they can play a role in overcoming the barrier created by cognitive dissonance. However, at our best knowledge, no studies have measured to which extent soft measures are able to reduce cognitive dissonance. The objective of the present work is to understand the relationship between awareness, attitude and behaviour in the context of mode choice. In particular this work aim to measure the efficacy of specific leverage, among all the information provided, that led to behaviour change, and to measure the relative importance of the soft measures compared to individuals' attitude toward environment or improvements in the supply characteristic. Understanding to what extent specific soft measures contribute to shaping individuals' preferences, is crucial for defining the best policy to encourage changes toward sustainable modes.

In our study we focus in particular on the effect of making people aware of the benefits of park and ride (P&R) as opposed to the car as driver and we test the effect of a reduction in CO₂, and in monetary costs. We investigate the effect of propensity towards environmental behaviour in the choice of private car versus park and ride (P&R). A hybrid choice model (Koppelman e Hauser, 1979; McFadden, 1986; Ben-Akiva e Boccara, 1987; Ben-Akiva, 1992; Ben-Akiva *et al.*, 1994;. Morikawa *et al.*, 1996.) is estimated jointly on the data before and after individuals are exposed to the soft measures.

The remainder of the paper is organised as follows: Section 2 describes the data collection and reports an exploratory analysis of the data. Section 3 describes the hybrid choice model set up while Section 4 discusses the model results. Section 5 contains the conclusions and suggestions for further research.

2. Data Analysis

The data used in this study are taken from a Personalised Travel Planning (PTP) programme conducted in Cagliari (Italy) from February 2011 to February 2012, to promote the use of a sustainable/environmentally friendly travel mode. The context is a corridor that connects the metropolitan area to Cagliari city centre, which carries 150,000 round car trips/day. In 2008, a short light rail line (6.3 km), named *Metrocagliari*, went into operation but to date only 5,000 travellers/day use it, about 75% below its capacity. Thus, the objective of the programme was to promote the use of an existing sustainable/environmental-friendly mode, thereby reducing the amount of car trips travelled along the corridor.

The programme involved a two-week data collection of the activity-travel patterns using a GPS active data logger (smart phone with built-in GPS and activity diary application), called Activity Locator (Meloni *et al.*, 2011). In particular, these are revealed preference data collected before and after the implementation of the soft measure, where people were provided with information to make them aware of the benefit of using environmentally friendly modes.

Soft measures were provided by the following two Personal information representing the benefits shown with the PTP:

- Economic benefit is equal to the difference between the annual cost of the car only trip and the annual cost of the P&R trip mode;
- Health benefit is equal to the difference between the calories consumed by each individual in the first week and computed on the basis of the number of metres walked from and to the car park, and the calories consumed by each individual, computed on the basis of the number of metres walked to and from the Metro station.

The survey also collected detailed information on individual and household socio-demographic characteristics and attitudes. As for the latter, the work focused specifically on the environmental attitude as we are interested in analyse its effect in relation to the awareness toward CO₂. A set of 4 questions were included in the questionnaire to measure the propensity towards environmental behaviour. In particular we asked:

1. Level of effort in reducing emissions from Waste
2. Level of effort in reducing emissions from Energy (moderate use of domestic energy)
3. Level of effort in reducing emissions from Daily behaviour (buying locals products, green food)
4. Level of effort in reducing emissions from Green technologies

The final sample gathered consisted of 85 participants of which:

- 21 Park and Riders (P&R), current light rail users
- 64 Prospective P&R (PP&R), *i.e.* current car users who could have travelled using the *Metrocagliari* in a P&R solution.

The sample gathered has a slight preponderance of females in both groups (P&R and PP&R), but it is uniformly distributed and similarly distributed among P&Rs and car users in terms of age groups. All participants possess a driving license and are car owners.

Table 1 shows the socioeconomic characteristics of the sample, while table 2 shows the travel mode distribution for weeks 1 and 2 and overall:

Table 1. Sample characteristics

	P&Rs	Car users
Employment status		
Students	19.0%	15.6%
Employees	66.7%	51.6%
Self employed	14.3%	28.1%
Unemployed	-	4.7%
Marital status		
Unmarried	85.7%	51.6%
Married	14.3%	48.4%
kilometres/year travelled by car		
< 15,000	76.2%	50%
15,000 - 20,000	9.5%	32.8%
> 20,000	14.3%	17.2%
Number of household members		
1-2 people	28.6%	45.40%
3-4 people	61.9%	43.80%
≥ 5 people	9.5%	10.80%
Presence of children		
Yes	23.80%	29.70%

Table 2. Travel mode distribution

	Overall		Week 1		Week 2	
	No.	Modal Split	No.	Modal Split	No.	Modal Split
PP&R	382	62%	218	67%	164	57%
P&R	282	46%	106	33%	126	43%
Total	614	100%	324	100%	290	100%

3. Hybrid Joint Choice Model

The typical assumption in a Discrete Choice Model (DCM) is that individuals possess intrinsic preferences, perfect knowledge about all the alternatives and are able to process all the information to choose the alternative that has the maximum utility. DCMs are often described as an “optimizing black box”, because the model directly links the observed inputs to the observed output, thereby assuming that the model implicitly captures the behavioural choice process. As showed by Kahneman and Tversky (1979), and confirmed more recently by numerous psychological studies (Olson and Zanna, 1993), individuals often exhibit departures from perfect rationality.

Awareness of the benefits of environmentally friendly modes and individual attitudes towards the environment are typical examples of the effects that make individual choices deviate from the typical neoclassical theory. To account for these effects in the mode choice we use a hybrid choice model estimated on two weeks, where the utility of the mode is affected by individual attitude towards the environment and by the awareness of the benefits of environmentally friendly modes.

In particular joint estimation of the discrete choice structure, using data gathered in the two weeks, allows us to estimate the effect of awareness while the latent structure allows us to estimate the effect of the latent environmental attitude. As in the typical discrete choice models, define U_{jnt}^w the utility that each individual n associates with alternative j , in the time period t , respectively before ($w=B$) and after ($w=A$) receiving information about the benefits of using Park and Ride (P&R) instead of the private car. The joint model can be written as:

$$\begin{aligned}
 U_{jnt}^B &= ASC_j^B + \beta_{jX}^B \mathbf{X}_{njt}^B + \beta_{jAtt}^B Att_n + \varepsilon_{jnt}^B \\
 U_{jnt}^A &= \theta \left(ASC_j^A + \beta_{jX}^A \mathbf{X}_{njt}^A + \beta_{jPI}^A PI_n + \beta_{jAtt}^A Att_n + \varepsilon_{jnt}^A \right)
 \end{aligned}
 \tag{1}$$

where:

\mathbf{X}_{njt} is a vector of level-of-service (LOS) characteristics. In particular, the vector in our study includes:

The travel time by car only is defined by means of:

- the travel time by car-only (from origin to destination)
- the travel time by car looking for parking
- the walking time from car parking to destination

The travel time by P&R is defined by means of:

- the travel time by car from origin to park-and ride
- the waiting time at the Metro station
- the travel time by Metro
- the walking time from park-and ride to Metro station
- the walking time from Metro station to destination

The travel cost by car only is defined by means of:

- the travel cost by car per km multiplied by the distance between the origin and the final destination
- the parking cost

The travel cost by P&R alternative:

- the travel cost by car per km multiplied by the distance between the origin and the park-and ride
- the metro ticket cost (the parking cost is included in the ticket)

PI_n is a vector of personal information: namely *Economic benefit* and *Health benefit*

Att_n^w is the latent variable that measures the environmental attitude of each individual n

β_{jX}^w , β_{jPI}^w and β_{jAtt}^w are the sets of coefficients associated with the above attributes

ASC_j^w are the typical alternative specific constants for N-1 alternatives

ε_{jnt}^w are random terms distributed identically and independently Extreme Value type 1 (i.i.d. EV1)

$\theta = \lambda^B / \lambda^A$ is a scale parameter that checks for different error variances in the two datasets

The model used is a typical joint model likewise the traditional joint revealed/stated preference model (Ben-Akiva and Morikawa, 1990). In contrast with that, in our case a possible change of mode (from car-only to P&R) cannot be attributed to some variation in attributes but to a greater level of information and awareness of the other (existing) alternative.

Personal information (I) is introduced into the utility of the P&R, in the second week, and is defined by the two variables (Economic benefit and Health benefit) representing the benefits of the PTP, as described in Section 2.

Following the theory of the hybrid choice models, the latent environmental attitude has the following structural equation:

$$Att_n = \text{Const-Att} + \xi \cdot \mathbf{S}'_n + \omega_n \quad (2)$$

where \mathbf{S}'_n is a vector of individual background characteristics that can differ from the vector included in the discrete choice model, ξ is a vector of coefficients associated with these background characteristics, Const-Att , and ω_n is an error term distributed Normal with zero mean and standard deviation σ_ω .

As indicators, we used responses to the survey questions about the level of commitment with respect to the following items: Waste, Energy, Daily behaviour and Green technologies. In addition to these four items, participants were also asked to express their level of commitment with respect to transport. However, since results in the literature demonstrated that there not exist direct correlation between propensity towards environmentally friendly behaviour and travel behaviour, we decided not to use this as an indicator of the latent variable.

For each indicator the respondent has to select one among: "Never, Shortly, Moderately, Highly, Extremely, I don't know"; the outcomes have then a natural ordering but no quantitative interpretation. Therefore we coded the answer using the Likert scale, i.e. a number ranging from 1 (= Not at all) to 5 (= Extremely), and we excluded the "I do not know" answers because assign zero to them means "null commitment", contrariwise could correspond to a "do not know / I will not answer".

Indicators are linked to the attitude with the following measurement equations:

$$I_{rn} = \text{Const-Ind}_r + \alpha_r Att_n + v_{rn} \quad r = 1, \dots, R \quad (3)$$

where I_{rn} is one of $r=1, \dots, R$ indicators for the latent variable, Const-Ind_r is the intercept, α_r is the coefficient associated with the latent variable (intercept and α_1 for the first indicator are normalised to 0 and 1 respectively for identification purposes), and v_{rn} is the error term distributed Normal with zero mean and standard deviation σ_{vr} .

The structural equation for the discrete choice is defined by the dummy variable, d_{jnt}^w , that takes the value 1 if the mode of type t has the greatest utility among all the alternatives in the choice set C_n of individual n :

$$d_{jnt}^w = \begin{cases} 1 & \text{if } U_{jnt}^w > U_{int}^w, \quad \forall i \neq j; (i, j) \in C_n \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

while the distributions of the latent variable and the indicator are respectively:

$$f_{Att}(Att_n | S_n; \xi, \sigma_\omega) = \frac{1}{\sigma_\omega} \phi\left(\frac{Att_n - \xi \cdot S_n'}{\sigma_\omega}\right) \quad (5)$$

$$f_{I_r}(I_{nr} | Att_n; Const-Ind_r, \alpha_r, \sigma_{v_r}) = \frac{1}{\sigma_{v_r}} \phi\left(\frac{I_{nr} - Const-Ind_{r>1} - \alpha_r Att_n}{\sigma_{v_r}}\right)$$

Indicators are expressed in a five-point numerical scale, so the measurement equation of the indicator (I_{rn}) is expressed as an ordered probit model:

$$P(I_{rn} = 1) = \frac{1}{1 + e^{[(Const-Ind_{r>1} + \alpha_r Att_n) - \eta_1]}} \quad (6)$$

$$P(1 < I_{rn} < 5) = \frac{1}{1 + e^{[(Const-Ind_{r>1} + \alpha_r Att_n) - \eta_1]}} - \frac{1}{1 + e^{[(Const-Ind_{r>1} + \alpha_r Att_n) - \eta_{l-1}]}}$$

$$P(I_{rn} = 5) = 1 - \frac{1}{1 + e^{[(Const-Ind_{r>1} + \alpha_r Att_n) - \eta_{l-1}]}}$$

where η_l are thresholds defined respectively as $\eta_1 = 0$; $\eta_2 = \eta_1 + \delta_1$; $\eta_3 = \eta_2 + \delta_2$.

The models can be estimated by maximum likelihood estimation. The choice probabilities are given by:

$$P_n = \int \prod_{\omega \in A, B} P_n^w [Att_n(\omega_n)] f_{Att}(\omega_n) \prod_{r=1, R} f_{I_r} [Att_n(\omega_n)] f(\omega) d\omega \quad (7)$$

The hybrid choice model was estimated using numerical integration methods, coded in PythonBiogeme.

4. Model results

In this section we describe the results of the mode choice models between car and P&R. Table 3 shows the best specification obtained after an extensive analysis carefully testing many different utility specifications.

As can be observed from Table 3, the signs of all the parameters of the LOS attributes are in agreement with the microeconomic theory and are all significantly different from zero, with a significance level of 95%.

Table 3. Model results

HCM		Estimate	t-test
Constant_P&R (week1)		-5.64	-4.55
Constant_P&R (week2)		-7.36	-5.83
X_{njt}	<u>P&R Attributes</u>		
	Travel time by car from origin to park and ride plus waiting time and travel time by Metro (week1 & week2)	-0.115	-3.00
	Walking time from park-and ride to Metro station (week1)	-1.97	-5.89
	Walking time from park-and ride to Metro station (week2)	-2.52	-6.73
	Walking time from Metro station to destination (week1 & week2)	-0.545	-5.53
	<u>Car Attributes</u>		
	Travel time by car-only (from origin to destination) (week1 & week2)	-0.445	-7.39
	Walking time from car park to destination (week1 & week2)	-0.853	-9.35
	Time looking for parking (week1)	-0.124	-2.54
	Time looking for parking (week2)	-0.155	-3.14
	<u>P&R and Car Attributes</u>		
	Travel cost (week1 & week2)	-0.657	-4.17
PI_n	<u>Personalised information</u>		
	Economic benefit <i>Beuro</i> (week2)	0.398	8.97
	Health benefit <i>Bcal</i> (week2)	10.7	3.75
Att_n	<u>Latent variable</u>		
	Constant_LV	0.727	5.61
	Environment attitude (week1 & week2)	0.513	1.35
	<u>Individual characteristics</u>		
	Age 31-40	0.905	8.90
	Age > 40	0.714	6.76
	Education (Specialization)	2.23	9.14
	Education (High School)	0.453	4.95
	Education (Master Degree)	0.494	5.11
	Number of household members	-0.101	-3.83
	Presence of children	0.197	2.13
	Random term (ω)	-0.677	-6.23
I_{rn}	<u>Indicators</u>		
	Delta1_Daily behaviour	2.15	16.33
	Delta2_Daily behaviour	1.74	12.59
	Alpha_Green technologies	2.47	9.80
	Delta1_Green technologies	1.90	9.54
	Delta2_Green technologies	2.29	13.75
	Alpha_Waste	1.01	10.24
	Delta1_Waste	2.34	18.64
	Alpha_Energy	3.69	8.25
	Delta1_Energy	4.45	8.80
Delta2_Energy	3.71	10.88	
L(max)		-2938.704	
ρ^2		0.389	
No. individuals		85	
Sample size		614	

Similarly to Meloni *et al.* (2013) the variables *Beuro* and *Bcal*, which describe the effect of personalised information related to the P&R alternative, has been included as specific of the park-and ride alternative in week 2, in order to associate it with the behavioural change. Both variables are highly significant and positive. This is correct as they were presented to the users as benefits.

The high significance of the two information variables confirms that they are important to explain the choice of environmental friendly modes and cannot be neglected. To quantify the impact of the soft measures in terms of number of individuals we could say that 17.2% of PP&Rs change mode during the second week, in terms of number of trips we could say that more than 50% of total trips were made using P&R.

The positive sign of the latent variable for propensity towards environmentally friendly behaviour, introduced into the car utility, may appear to be contradictory, as one would usually expect that eco-friendly people would have less utility for private car use. However, this result appears to reflect what was expected in this reference context. Indeed, despite showing a marked propensity towards eco-friendly behaviour, this pro-environmental attitude is not sufficient to induce them to change their travel mode from car to P&R. This result, in agreement with the branch of environmental psychology that studies these aspects, may be explained by the presence of cognitive dissonance and hence inconsistency between attitudes and behaviour.

Note in fact that the participants revealed a marked propensity towards environmentally friendly behaviour, as testified by the responses to each of the four indicators used to render the latent variable explicit. Indeed, the average value is greater than 3 for each indicator, thus the participants exhibit at least a moderate commitment for each of the four indicators. Also interestingly the only area where participants stated lesser commitment was actually for travel, with an average value of less than 3. This aspect could also be an expression of the effect of substitution/trade off: *I am pro-environmental in these four areas, because I cannot travel in an environmentally friendly way.*

Regarding the socio-economic characteristics that define the attitude towards environment, model's results show that the individuals over 30, with a high school degree or higher have the highest propensity toward environment. Regarding household characteristics, people with children have the highest attitude, while attitude decreases with the number of household members.

5. Conclusions

Private car users often find it difficult to change their travel behaviour by using more sustainable modes. Indeed, despite being aware and well informed - also thanks to information campaign - of the fact that more responsible behaviour is needed to protect the environment, this does not have immediate repercussions on their travel behaviour. Even environmentally aware users who are careful to adopt a green lifestyle (separating waste, energy savings, *etc.*) find it hard, and often do not succeed in committing themselves when it comes to changing their daily travel by private car. Thus pro-environmental motivation is not sufficient to engage in behaviour that replaces or reduces private car used in favour of sustainable travel modes. Thus, in a transportation context, one often encounters cognitive dissonance, *i.e.* inconsistency between attitude and behaviour, The motivation for this dissonance in the specific context, lies in the following factors:

- the large number of car owners and cars per household, on average two in the sample examined;
- the poor capillarity and integration with the public transport network, in the specific case associated above all with the short distance covered by the light rail line and poor integration with the bus network;

- our frenetic modern lifestyle resulting in the need to chain trips, difficult to achieve with travel modes other than the private car; we found that the number of stops in car mode is three times higher than P&R mode;
- the alternative to the private car proposed here contemplates in any case using the car, be it for a short distance;
- due to the trade-off effect, environmental awareness is encountered in other sectors, precisely because users are conscious of the fact that they are unable to travel in sustainable modes;
- people do not appear to behave in an eco-friendly manner in different areas or sectors: pro-environmental behaviour in one area does not necessarily mean that people will behave in the same way in other areas.

Our findings seem to confirm that cognitive dissonance does indeed exist, especially between environmental attitude and behaviour. Despite being pro-environmental, individuals do in fact behave differently. Our results also demonstrate that soft measures aimed at making people aware of the environmental consequences of their current behaviour are not enough to overcome cognitive dissonance. Soft measures seem on the other hand to be effective when they make people aware that they are rejecting a more beneficial travel mode with respect to the private car (economic and health benefits). In this context, social psychology offers six specific persuasion techniques (Cialdini, 2001) that, based on deeply seated human needs, seem to be equally suitable for private sector marketing as for community based social marketing strategies, and which are able to reach beyond the mere raising of awareness and knowledge.

Undeniably, the sample used in the present study, dictated by available resources, was small and probably not representative of the population as a whole. Notwithstanding this, the results appear to be in line with the reference context and with the findings of current transportation research. One of our future objectives will be to expand the sample size to strengthen the research work conducted so far.

Acknowledgements

The Authors are grateful to the Sardinian Government for funding the project (Legge7/2007).

References

- Ampt, E. (2003) Voluntary Household Travel Behaviour Change - Theory and Practice. *10th International Association of Travel Behaviour Research Conference, 10-15 August, 2003*, Lucerne, Switzerland.
- Ben-Akiva, M. and Boccara, B. (1987) Integrated Framework for Travel Behaviour Analysis. *Presented at the International Association of Travel Behavior Research (IATBR) Conference, Aix-en-Provence, France.*
- Ben-Akiva, M. and Morikawa, T. (1990) Estimation of travel Demand Models from Multiple Data Sources. *Transportation and Traffic Theory*, pp. 461-476.
- Ben-Akiva, M. (1992) Incorporation of Psychometric Data in Individual Choice Models. *Presented at the American Marketing Association Advanced Research Techniques Forum, Lake Tahoe, Nevada.*
- Ben-Akiva, M., Bolduc, D. and Mark, B. (1994) Estimation of Travel Choice Models with a Distributed Value of Time. *Transportation Research Record 1413*.
- Bonnes, M., Carrus, G. and Passafaro, P. (2006) *Psicologia ambientale, sostenibilità e comportamenti ecologici*. Roma: Carocci.
- Bonsall, P., Shires, J., Maule, J., Matthews, B. and Beale, J. (2007) Responses to complex pricing signals: theory, evidence and implications for road pricing. *Transportation Research Part A 41(7)*, pp. 672-683.
- Cialdini, R. B. (2001) Harnessing the science of persuasion. *Harvard Business Review 79(15)*, pp. 71-80.
- Fujii, S. and Taniguchi, A. (2005) Reducing family car-use by providing travel advice or requesting behavioural plans: An experimental analysis of travel feedback programs. *Transportation Research Part D 10*, pp. 385-393.

- Gärling, T. and Fujii, S. (2009) Travel behaviour modification: theories, methods, and programs. In: R. Kitamura, T. Yoshi and T. Yamamoto (eds.) The expanding sphere of travel behaviour research. IATBR, pp. 97-128.
- Hines, J. M., Hungerford, H. R. and Tomera, A. N. (1987) Analysis and synthesis of research on responsible environmental behaviour: A meta-analysis. *Journal of Environmental Education* 18(2), pp. 1-8.
- Hornik, J., Cherian, J., Madansky, M. and Narayana, C. (1995) Determinants of recycling behaviour: A synthesis of research results. *Journal of Socio-Economics* 24(3), pp. 105-127.
- IEA (2010) CO₂ emissions from fuel combustion: highlights. *International Energy Agency*, Paris.
- Johansson, M. V., Heldt, T. and Johansson P. (2006) The effects of attitudes and personality traits on mode choice. *Transportation Research Part A* 40(6), pp. 507–525.
- Jones, P. and Sloman, L. (2003) Encouraging Behavioural Change Through Marketing and Management: What can be achieved? *10th International Association of Travel Behaviour Research Conference, 10-15 August 2003*. Lucerne, Switzerland.
- Kahneman, D. and Tversky, A. (1979) Prospect Theory: an analysis of decisions under risk. *Econometrica* 47, pp. 313-327.
- Koppelman, F. S. and Hauser, J. (1979) Destination Choice for Non-Grocery-Shopping Trips. *Transportation Research Record* 673, pp. 157-165.
- McFadden, D. (1986) The choice theory approach to marketing research. *Marketing Science* 5(4), pp. 275-297.
- Meloni, I., Spissu, E. and Bhat, C.R. (2011) The effect of personal cap-and-trade mileage policies on individual activity-travel patterns. The Activity Locator project. *Transportation Letters: The international Journal of transportation research*, 3, pp. 293-307.
- Morikawa, T., Ben-Akiva, M. and McFadden, D. (1996) Incorporating psychometric data in econometric choice models. Working paper. Cambridge: Massachusetts Institute of Technology.
- Olson, J. M. and Zanna, M. P. (1993) Attitudes and Attitude Change. *Annual Review of Psychology* 44, pp. 117-154.
- Richter, J., Friman, M. and Gärling, T. (2011) Soft transport policy measures: gaps knowledge. *International journal of sustainable transportation* 5(4), pp. 199-215.
- Rose, G. and Ampt, E. (2001) Travel blending: an Australian travel awareness initiative. *Transportation Research Part D* 6, pp. 95-110.
- Rose, G. and Ampt, E. (2003) Travel behaviour change through individual engagement. In: D.A. Hensher and K. J. Button (eds.) *Handbook of transport and the environment*, edited by 2003, Elsevier Science Ltd.
- Stern, P. C. and Oskamp, S. (1987) Managing scarce environmental resources. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology*, pp. 1043-1088. New York: Wiley.
- Schwanen, T., Banister, D. and Anable, J. (2011) Scientific research about climate change mitigation in transport: a critical review. *Transportation Research Part A* 45(10), pp. 993-1006.
- Stopher, P. (2005) Voluntary travel behaviour change. In K.J. Button and D.A. Hensher (eds.) *Handbook of Transport Strategy, Policy and Institutions*, Elsevier.
- Taniguchi, A., Hara, F., Takano, S., Kagaya, S. and Fujii, S. (2003) Psychological and behavioural effects of Travel Feedback Program for travel behaviour modification. *Transportation Research Record: Journal of the Transportation Research Board* 1839, pp. 182-190.
- Tertoolen, G., Van Kreveld, D. and Verstraten, B. (1998) Psychological resistance against attempts to reduce private car use. *Transportation Research Part A*, 32(3), pp. 171-181.
- Thøgersen, J., Ölander, F. (2003) Spillover of environment-friendly consumer behaviour. *Journal of Environmental Psychology* 23, pp. 225–236.