Transport mode ON: How to set a discrete choice survey to predict commuters' mode preferences

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Abstract

The commute trip (to work, education, etc.) is generally the most commonly scheduled and realized trip purpose. For the working population, the commuting trip is by far the trip that makes people spend the most miles. Also, commute trips have temporal and geographic regularity. Thus, they stress a lot the transportation network, since they are really concentrated in time (pick hours) and space. On top of this, car ownership is increasing, as more and more people use their cars for every day commuting. Mainly, people who work in capital cities often face the most lengthy journey times to work and some of the most extended delays due to traffic congestion (Eurostat, 2015). Research has revealed that the length of the average EU commute is estimated to be 37.5 minutes per day. The mode of transport used for the commute trip, as well as many other actions humans take in life, demand to some degree making a decision that involves choice.

In this paper, we discuss the commute trip and its trends for the next years. Additionally we describe how we build a Stated Preference Survey, using the Discrete choice model in order to find the most strong predictors regarding the commute trip taking into account both attitudinal attributes, that focus on cognitive determinants of travel mode choice; and situational attributes which are characterized by a focus on travel mode characteristics and socio-demographic factors. We explain the steps that we followed in order to build the survey, as well as the data population. Finally, a short discussion on the tools that will be used for the analysis of the survey takes place. The current work can be used as summative guidance to whoever wants to build a stated preference survey regarding mode choice. The results of the survey will be discussed in future work.

Keywords: *commuting, discrete choice model, transport mode, stated preferences.*

1 Introduction

People mainly travel to participate in activities. These activities can be either simple (one destination activity per trip) or complex (multiple destinations activities per trip), and they most possibly occur in different places due to biological needs, social obligations and personal desires (Vilhelmson, 2007). These activities are usually sequential, since not all activities can take place simultaneously, and this entails that one or more trips will have to be made. Some activities, for example work, are repeated over time, even daily and they are leading to travel patterns that become established to travellers' minds and schedules.

The commute trip (to work, education, etc.) is generally the most commonly scheduled and realised trip purpose. For the working population, commuting is by far the trip that makes them spend the most miles, especially in comparison to the non-working population. Also, commute trips have temporal and geographic regularity. Thus, they stress a lot the transportation network, since they are concentrated in time (pick hours) and space. Finally, people who commute, tend to organise all their other trips' activities around this core one.

It is a fact that nowadays people living in and around the EU's biggest cities spend a considerable amount of their lives commuting from home and work. Today in European countries the average trip length by car is about 13-15 km per adult and day, while 20-30% of all these trips are for commuting purposes, according to EEA (2016). Thus planning the commute trip in the most efficient way and validating its characteristics, making everyday decisions, is really crucial for almost everyone. So, like most of the actions we take in life, the commute trip demands to some degree making a decision, and this involves choice.

There is a steady research interest on peoples' choices of transport mode, since papers that cope with this issue continue to emerge ((Bamberg & Schmidt, 2003), (Klöckner & Mattheis, 2004), (Collins & Chambers, 2005), (Murtagh & Uzzell, 2012)). The choice of travel mode is an issue that has concerned lots of studies, and that is affected by many factors, from situational and transport-specific ones (describing the various components of the transport system) to individual-related ones such as a person's attitudes, habits and identity.

In our research we have decided to study the topic of transportation mode choice from two perspectives. The attitudinal one, that has a strong focus on cognitive determinants of travel mode choice; and the situational one which is very much characterized by a focus on travel mode characteristics and socio-demographic factors.

The present paper has one main goal which is to provide a summative framework that can be followed in order to build a discrete choice model survey related to the modal use. This framework includes defining the attitudinal and the situational attributes that should be included in a survey related to the modal use and also defining the levels of the attributes and their range. Additionally, the set of the users' sample is proposed as well as the statistical tools that could be used for the analysis of the survey results.

2 Literature review

2.1 Travel behaviour

There is a steady research interest on peoples' choices of transport mode, since papers that cope with this issue continue to emerge ((Bamberg & Schmidt, 2003), (Klöckner & Mattheis, 2004), (Collins & Chambers, 2005), (Wall, Devine-Wright, & Mill, 2007), (Murtagh, Gartersleben, & Uzzell, 2012)). Especially, commuting behaviour and mode choices have been heavily studied for decades using a wide range of methodological approaches.

Mode choice is affected by a great many factors, from situational and transport-specific ones (describing various components of the transport system) to individual-related ones (attitudinal) such as a person's attitudes, habits and identity. These factors can be classified into two broad categories. There are hard factors like travelling time, waiting time and ticket price (fare) which are easy to measure and quantify. These factors have been used in most of the conventional research on travel behaviour based on utility theories, assuming that individuals make **conscious** decisions from the evaluation of these hard factor alternatives. However, these hard factors cannot explain the many cases were individuals in similar situations and with corresponding characteristics (i.e. socioeconomic) make different choices (Heinen, Maat, & van Wee, 2011). Thus, also soft factors have received increased attention as a predictor of travel behaviour the recent years. These factors include measures like comfort, service and information (Loncar-Lucassi, 1998) or flexibility, ease of use and autonomy, which are not quantifiable in an easy way.

The most used theory for predicting the mode choices is the Utility Theory (UT), which is based on the Rational choice theory assuming that people aim to maximise their utility by minimising the time and cost of travel, partly by acting completely rational. This is the usual starting point for mode choice predictions and they are sometimes modified to take into account research specific, constraints (Banister, 2002). Another theory that has been widely adopted by researchers seeking to explain transport choices is the Prospect Theory which was developed in the 1970s as a behavioural-economic alternative to Utility Theory. Prospect Theory is mainly addressed through heuristics and implemented in transport by, for example, Avineri and Bovy (2008) to predict travellers' choices under risk and uncertainty, involving attributes like travel time reliability. Li and Hensher (2011) put a critical review of the majority of the studies that used Prospect Theory and concluded that on its own it is not enough to infer valid behavioural transport models and it should be combined with models regarding preferences of the user, seeking for a hybrid approach.

Lately, efforts have been made to adopt theories that combine psychology with statistical accuracy. An extensively used example is the Theory of Planned Behaviour (TPB), proposed by Ajzen (1991) that seeks to capture the highly complicated transport choice prediction by connecting phycological attributes like attitudes, social norms, and perceived behavioural control, influenced by spatial and socio-demographic characteristics (Keyes & Crawford-Brown, 2018).

A way to predict users' choices is the discrete choice models, deriving from the field of economics. Discrete choice models aim to describe, explain, and predict choices between two or more discrete alternatives, based on individual choice behaviour theory (Ben-Akiva & Lerman, 1985) using parameterised utility functions. Such utility functions incorporate independent, as well as observables variables and unknown weighting parameters. In discrete choice models, users are asked to make a decision, facing a set of alternatives which should be exclusive, and included in choice sets that need to be exhaustive (all possible alternatives are included in the choice set) having a finite number of alternatives.

The discrete choice family of models has been used for decades. Especially mode choice models, as Abou-Zeid and Scott (2011) comment, constitute one of the earliest applications of such models in the '60s and '70s and continue to be extensively used by transportation researchers. When considering choice models, it is possible to gather data using two distinct ways: stated preferences (SP) surveys and revealed preference (RP) surveys. SP surveys, also called self-stated preferences, have been widely applied in the areas of marketing and travel demand modelling. According to Kroes and Sheldon (1988), SP methods refer to "a family of techniques which use statements of individual respondents about their preferences" in a set of alternatives (choice sets) to estimate utility functions. SP data are collected through experimental situations or surveys where the respondents are faced with hypothetical choice problems. On the contrary, revealed preference data allows analysis of choices that have already been made, often combining population-level and/ or longitudinal metrics with contextual variables.

2.2 Commuting

In the last decades, urban areas worldwide have become more automobile-dominated and less sustainable. Cities all around the world and Europe, have experienced rapid growth in transport-related challenges including pollution, congestion, accidents, public transport decline, environmental degradation, climate change, energy depletion, visual intrusion and lack of accessibility. On top of this, car ownership is increasing, as more and more people use their cars for every day commuting.

Urban journeys tend to become longer, since most capital cities, where the vast population has gathered at, have turned into megacities. Mainly, people who work in capital cities often face the most lengthy journey times to work and some of the longest delays due to traffic congestion (Eurostat, 2015). OECD (2017) has calculated that workers in OECD countries spend on average 38 minutes per day commuting. Eurostat in its report about "Urban Europe — Statistics on cities, towns and suburbs" enhances the above statement of OECD. It is stating that people living in and around the EU's biggest cities spend a considerable amount of their lives commuting from home and work. In the U.S., things are better, since the average commute time is 26 minutes, approximately 10 minutes less than in E.U., according to the U.S. Census Bureau. Nevertheless, this had gotten nearly 20% longer since the Census began tracking this data in the 1980s when typical commute time in the U.S. was 21.7 minutes.

Today in European countries the average trip length by car is about 13-15 km per adult and day, while 20-30% of all these trips are for commuting purposes, according to EEA. Even though cars are mainly made for higher speeds and longer trips, they are still the predominant means for local transportation (about 80% of all trips made by car are less than 20 km long, and 60% are less than 10 km long). At the same time, the commuting journeys made by private car increased more than the ones made by public transport. According to EEA, while 59% of all trips are made by car, when commuting, this percentage rises to 71% (EEA, 2016).

Based on the outcomes of the Flash Eurobarometer “Future of transport” (2014) survey, 56% of EU citizens used motorised means (car or motorbike) as their main mode of transport for their daily activities (including commuting), while about one in five (19%) used public transport. “Walking” was mentioned by 14% of EU citizens and “cycling” was selected by 8% of them. In the rest of the world, things differ, for example in Australia where four out of five workers (80%) are car commuters (Australian Bureau of Statistics, 2009). At the same page more or less is also Canada, where 82% of the commuters rely primarily on cars for their trip to work, while 12% take public transport and only 6% use a more active mode of transportation like walking or bicycling (Turcotte, 2011). Likewise in the USA, 86% of commuters travel to work by car (McKenzie & Rapino, 2011).

3 Methodology

3.1 *Procedure and participants*

The study will be conducted with participants from Athens and it will be an online survey. The online survey will be in Google forms which will be sent to possible participants through email and social networks (Facebook, Instagram). The target is to gather at least 200 answers. The target of the number participants, as well as the number of scenarios as it will be described in the following Section, was determined by the literature. Omre (2010) suggest the pooling of choices to be made by minimum 150 respondents, each of whom is observed to make eight choices, thus producing a total of 1,600 choice observations. Omre developed a rule of thumb equation:

$$N >= 500 * \frac{L}{J * S}^{max}$$

Where L^{max} is the largest number of levels for any of the attributes, S is the number of choice tasks each respondent faces and J is the number of alternatives. Taking this equation into account each of our user groups should have at least 63 respondents, thus 126 in total. So the target of 200 respondents that we set, is more than enough.

The survey consists two parts; the first one is related to the user characteristics, including all attributes described in Section 4.2 Attitudinal - personal characteristics and the second one is related to the trip characteristics described in Section 4.1 Situational - trip characteristics.

3.2 *Survey design*

Analysis of how travel decisions, like mode choice decisions, take place can be predicted by specific trip characteristics (situational attributes) or personal characteristics (attitudinal attributes) which require granular and aggregated data on individual travel and personal behaviour, as well as suitable statistical tools. Regarding the trip characteristics, Stated Preferences experiments are used widely today to determine the independent influence of various factors on the decisions made by individuals facing a choice situation, like the modal choice one.

The methods used to design statistically robust Stated Preferences experiments have been developed considerably since such experiments were first introduced to the field of transportation research nearly 20 years ago (Louviere, Hensher, & Swait, 2000). The experimental design of any choice experiment involves the planned manipulation of attribute levels to yield a statistically relevant output.

In creating an experimental design, after defining the choice problem, we must define the alternatives, as well as a number of attributes with assigned levels which are used to generate hypothetical scenarios. Alternatives in choice models are viewed as a set of aspects that are known, while the randomness in choice comes from the decision rule. In order to fulfil the global utility-maximizing rule, discrete choice set must be complied, which contains a universal but finite number of alternatives. The universal choice set contains all potential alternatives in the application's context. If the universal choice set is too extensive to create a practical choice experiment, a choice set that is a subset of the universal choice has to be created. The alternatives included in the choice set have to fulfil the following three characteristics.

1. Be **mutually exclusive**. Choosing one alternative implies not being able to choose any of the other alternatives.
2. Be **exhaustive.** All possible alternatives are included.
3. Be **finite**. The number of alternatives should be countable.

The first and second criteria are not restrictive, but the third one is. So, defining the correct number of alternatives in the choice set may have impact upon the statistical power of the experiment.

The methodology used in this paper draws from state-of-the-art practices in commuting and mode choice research and it includes the following three steps:

1. Defining the **choice problem**
2. Defining important **alternatives** and **attributes**
3. Defining the **experimental design** of SP survey

3.3 Analysis strategy

Discrete choice modelling is typically analysed using multinomial logistic regression (MNL). This method of analysis allows testing the associations between relevant variables and the likelihood of choosing one option over another, and this is what made it popular for modal choice research (Hensher, Rose, & Greene, 2005). It can be applied to repeated observations over time or, as in this case, a one-off survey dataset. The outputs of MNL are in the form of odds ratios, which can be interpreted to determine whether there is a correlation between the choice of a mode and the variable being tested, as well as the direction and scale of this association. MNL is therefore very appropriate for analysis of large survey datasets containing stated preference data on mode choice and a variety of potential explanatory variables. However, the mathematical form of MNL involves an assumption that the set of unobserved utility components are independent and identically distributed for each option in the choice set, which may not reflect reality.

Recently, researchers have used more complex variations of logit like hybrid and mixed logit models. Brownstone, Bunch, and Train (2000) applied multinomial and mixed logit models to stated and revealed preference data on types of car. Greene and Hensher (2003) applied such models to stated preference data on a choice between roads for a long-distance trip. More recently, Cherchi and Mancha (Cherchi & Manca, 2011) tried to incorporate inertia into modal choice modelling also using multinomial and mixed logit models. Multinomial and other forms of discrete choice models allow a considerable insight into stated preference datasets, however, the extent to which coefficients can be compared between analyses is limited by contextual differences (Keyes & Crawford-Brown, 2018).

In our study we will use Multinomial Logit to analyse the results of the survey, but we will also check and juxtapose the MNL outcomes with other analytical methods like mixed logit. Also we will check if there are differences in the results when using user clustering groups instead of taking into account individual data. The categorization of user will be done using cluster analysis based on their personal information.

4 Stated preferences survey experimental design

4.1 Situational - trip characteristics

According to the methodological framework described in the previous section, first of all the choice problem should be developed and refined. In order to increase the realism of the stated choice experiment for the respondent, there was a need to include features of an actual trip. Therefore, a focus group discussion was realised to cope with the problem studied and to assist in addressing the universal but finite list of alternatives to be use and the realistic attributes to be assigned for each alternative.

Because the list of alternative modes of transportation that could be used for commuting is quite long, and includes at least 15 alternatives, it was necessary to use focus groups to select the most significant alternatives to include in the choice experiment. An additional challenge was to settle the availability of selected modes (not all modes are available for all origin-destination pairs). Also, the success of the survey depends heavily on how realistically the choice scenarios can be illustrated so that potential biases in the data are minimized.

The objectives of the focus group were; to define the possible **alternative modes** to use in our survey, and to define characteristics of the commuting trip in Athens.

4.1.1 Focus group outcomes

Since we discuss commute trips, which are trips that are already realised (existing ones) the focus groups seemed to be one of the best ways to create realistic choice sets. A focus group discussion was conducted in Athens in December 2018. The objectives were to find aspects of transportation modes and services that could act as attractive or repulsive factors, to identify important attributes characterizing the commute trip that may be used in the Stated Preferences survey, and to identify potential attitudinal aspects that could be included in the Stated Preferences survey also.

The topics under discussion during the focus group was.

- the commuting trip frequency;
- the mode of transportation for the commuting activity;
- the most important elements that would affect the travel behaviour towards the commuting trip;
- the time travel of the commuting trip;
- the cost of the commuting trip;
- the environmental awareness of the commuting trip.

The main findings of the focus groups discussion are the following.

- All participants commute to work every day.
- All participants own a car, but not everyone is using it.
- Most of the participants use a car for their commute (as drivers or passengers) while the rest use PT and specifically metro, in combination with bus sometimes. Only one participant uses a bicycle some times for the commuting trip.
- The participants who use a car for their daily commute spend 15-60 minutes for their trip. A participant who spends less than 15 minutes though would be happy if the commute trip time was realized up to 20 minutes.
- The participants who use PT spend more than one hour for their commute.
- Some of the participants who use the car would not change it with any other mean of transport despite the circumstances. Most of them though would change to PT if there was an accessible stop near their home and work and if the service was more comfortable and reliable.
- The participant who uses the bicycle spends the same amount of time on the bike as with the car. The reasons behind not using the bicycle permanently are the physical fatigue required, as well as the low level of safety during the trip.
- Relate to the environmental friendliness of the trip, all respondents were interested in it and would take it into account if related data were available.
- Finally the most important attributes related to their trip were the travel time and cost, followed by some attitudinal factors such as environmental friendliness, security, reliability, flexibility, and comfort.

4.1.2 Implementation of Discrete Choice methods in the Stated Preferences survey

The data collected from the focus groups were incorporated into the stated choice experimental design to create a realistic choice situation for the survey participants. Based on the information selected from the focus groups one hypothetical scenario was presented to the survey:

"You leave in a suburban (or urban) area and you have to commute to and from work every day. You have availability to private car, as well as access to public transport and softer means of transport like bike are available to. Considering that all the other attributes are similar, each mode proposed in the following scenarios has different time[1] (in minutes), cost[2] (in euros) and environmental friendliness[3] (high, medium, low) and you are aware of the levels of these attributes before you make the decision which mode you will choose."

The list of alternative modes of transportation that could be used for commuting is quite long, and includes at least 15 alternatives. Since a universal but finite list of all the existing alternatives has to be compiled, it was decided to use a set of four alternatives which were extracted from the focus group discussion. This set of transportation mode alternatives that were used in the choice experiment includes, the car, the bus, the train which incorporates the light train, the train and the metro and the bicycle. This walking alternative was omitted because a distance that is comfortably covered by foot is typically much shorter than that covered by public transportation, private car or bicycle. Moreover, the focus group discussion revealed that the distance covered from the user was so long that it was not feasible to be realised on foot.

Once the alternatives to be included in the choice experiment were decided upon, it was necessary to determine which attributes should be included to describe each of the alternatives. Although it may have been possible to include alternative specific attributes, it was decided to decrease complexity by including common attributes to describe some or all of the attributes. In an attempt to make the experimental design more manageable, efficient and balanced, it was decided to include three attributes for each of the alternatives. From the focus group discussion, it was concluded that the most important aspects that the users take into account in their trip are the **cost** and the time. All the other aspects of the trip were not that important to the users. Moreover, a very critical instant in this experiment was related to the second hypothesis that is based upon the environmentally friendly decision of the user. So, the third attribute of the alternatives was the environmental friendliness of the trip. Nevertheless, as found in many previous mode choice experiments, the influence of similar attributes on the total utility of different modes tends to be different. Thus, different β parameters were set in the utility function depending on the mode alternative. Finally, research has shown that the levels associated with a common attribute may vary for different alternatives. For example, depending on the trip characteristics, the travel time by bicycle, car and public transportation tend to be quite different. But, since the data for the levels of the attributes have been extracted from the focus group and attribute levels seemed to be concentrated around reported values, it was possible to use common attribute levels for the different alternatives.

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[1] Time describes the total, door to door time including the time needed for parking and moving at special lanes, etc. For public transport, travel time includes the time needed to access the station.

[2] Cost for private car takes into account all possible operating (fuel/ gas/ electricity), purchase, tax, insurance and parking costs. For public transport, it refers to fare costs for a single journey. The cost form public transport is the fare.

[3] A highly environmental friendly trip is one that has small environmental footprint. On the other hand, a trip that is low environmentally friendly has a great environmental footprint.

Each of the attributes was described by a number of levels; three or four levels. The attribute levels were decided upon using a mixed approach, by blending the data extracted from focus groups and optimizing them with information from previous research projects that yielded results with high validity. The attribute levels should be selected in such a way that they reflect the estimation of the indifference curve. If the attribute levels are correctly selected, the variation of the attribute levels in the different choice situations will marginally influence the decision of the respondent. The attributes organized by alternative as well as the selected attribute levels will are presented in the following table.

Table 1: Alternatives, attributes and corresponding levels

Alternatives (j):	Attributes	Attribute Levels
Car	Travel Time	20, 30, 50, 60
	Travel Cost	3, 5, 8
	Environmental friendliness	Low, Medium, High
Bus	Travel Time	20, 30, 50, 60
	Fare	1.4, 2, 3.5
	Environmental friendliness	Low, Medium, High
Train	Travel Time	20, 30, 50, 60
	Fare	1.4, 2, 3.5
	Environmental friendliness	Low, Medium, High
Bicycle	Travel Time	20, 30, 50, 60
	Environmental friendliness	Low, Medium, High

The success of the experiment involves maximising not only its statistical validity, but also from the nature and complexity of the experiment itself. Bech et al. (2011) in their respective experiment studied the way the number of scenarios affects the results of the discrete choice models. They elucidate that respondents that were asked to choose between 17 choice sets had higher response fluctuation compared to those exposed to 5 choice sets; postulating that cognitive burden is increased as the number of choice sets goes beyond a certain threshold. Thus, in our study sixteen scenarios have been developed and were divided into two groups. Half of the participants will answer the one group of 8 scenarios and the other half will answer the other group of 8 scenarios. This action was decided since we wanted to avoid overloading each user with a great number of scenarios which most probably would end up in bias in our results due to user's fatigue.

The experimental design of the choice experiment was created using Ngene, a software that is distributed by ChoiceMetrics (www.choicemetrics.com). An example of the choice sets used in the survey questionnaire are presented in Table 2.

Table 2: Example of a labelled choice set submitted to commuters

Scenario 1				
	8	5	5	1
	60	60	60	60
	Med	Low	Med	High
Your choice	☐	☐	☐	☐

Scenario 2				
	8	8	5	2
	50	30	20	60
	Low	Med	Low	High
Your choice	☐	☐	☐	☐

Once the alternatives, attributes and attribute levels to be included in the experiment have been determined, the model has been specified. The modelling framework that was used for this research project was a discrete choice analysis one. This was selected because data was gathered using a stated choice experiment, where respondents are asked to choose between four discrete alternatives; car, bus, train and bicycle. The respondent is expected to choose the alternative that maximizes their net utility and select the mode alternative that provides the highest utility for each one of them. The utility function is comprised of a deterministic and a random component. The deterministic portion of the utility function can be described as a vector of preference parameters, and a vector of alternative attributes and personal characteristics of the respondent. Following random utility theory, individual q's choice is determined by his or her utility from selecting alternative i denoted U_{iq}. The observable indirect utility function V_{iq} is assumed to be a function of the attribute levels X_{iq} describing alternative i in the choice set $(i = 1, \dots\dots, I)$. For convenience of notation, the respondents' individual characteristics (which are constant across choices) are assumed to be included among the X_{iq}. Thus, an individual's utility from choosing alternative j is specified as

$$U_{iq} = V_{iq}\,(X_{iq}, \beta) + \varepsilon_{iq}$$

where β is a vector describing the part-worth utility of the attribute parameters
More specifically the utility functions used in this choice experiment are formed as follows:

$$U_{car} = V_{car}\,(X_{car}, \beta) + \varepsilon_{car}$$
$$U_{bus} = V_{bus}(X_{bus}, \beta) + \varepsilon_{bus}$$
$$U_{train} = V_{train}(X_{car}, \beta) + \varepsilon_{train}$$
$$U_{bicycle} = V_{bicycle}(X_{car}, \beta) + \varepsilon_{bicycle}$$

Since Independence from Irrelevant-Alternatives (IIA) axiom has to be fulfilled, the distribution of all «ε» error terms defined in the choice model must be identical. By making such assumptions about the error component, it is possible to focus on the systematic component of the utility function. The systematic portions of the three equations can be expanded to include the attributes and their weighting parameters, as shown below.

$V_{(Car)} = b_{0Car}+b_{1Car}$*cost + b_{2Car}*time + b_{3Car}*environmental friendly
$V_{(Train)} = b_{0Train} + b_{1Train}$*fare + b_{2Train} *time + b_{3Train} *environmental friendly
$V_{(Bus)} = b_{0Bus} + b_{1Bus}$ *fare + b_{2Bus} *time + b_{3Bus} *environmental friendly
$V_{(Bicycle)} = b_{1Bicycle}$ *time + $b_{2Bicycle}$ *environmental friendly

4.1.3 Additional trip characteristics

A lot of research has been done with respect to situational characteristics of a trip that may influence the travel mode choice, also. Within the analysis of transportation choices the state of the art indicates that there are many latent variables that have been taken into consideration. Latent variables common to almost all transport modes include comfort ((Yáñez, Raveau, & Ortúzar, 2010), (Paulssen, Temme, Vij, & Walker, 2014), (Márquez, Cantillo, & Arellana, 2014)), accessibility (Yáñez, Raveau, & Ortúzar, 2010), flexibility (Paulssen, Temme, Vij, & Walker, 2014), convenience (Paulssen, Temme, Vij, & Walker, 2014), connectivity (Puello & Geurs, 2015) and resistance to change (Link, 2015). Some of the aforementioned were aslo captured from our survey and will be correlated to the respondents mode choices.

One powerful predictor of travel mode choice for example is the car availability. The easier a car can be accessed, the higher the likelihood that a car is used. For example Van Acker and Witlox (2010) propose that there is correlation between car ownership and socio-economic/ demographic variables, built environment characteristics and car use. Similarly, important is the frequency of the commuting trip. For example, Gebeyehu and Takano (2007) found that the frequency, among others, influenced greatly the travel choice of bus. Another characteristics that could affect the decision of mode for the respondents is the variability of transport modes already used (multimodality) by them in their commute trip. Heinen and Chatterjee (2015) with their literature research found that multiple modes are used by most travellers in their overall trips during a given time and this is also the case even for specific types of travel such as commuting. Finally other soft factors like trip comfort, safety, flexibility, control, carbon footprint etc. may also affect the mode choice decision. Ding and Zang (2016), in their research in Nanjing City of China found out that travellers with higher income would like to choose a more comfortable mode and that females and elders regard comfort as the primary concern when commuting.

4.2 Attitudinal - personal characteristics

Another critical part of our survey apart from the situational characteristics, are the attitudinal characteristics of the user. The scope of this part of the questionnaire is to gather feedback from users based on their personal preferences regarding some attitudinal aspects and correlate them to the situational aspects of their trips, so as to find if there can also be predictors of their travel and mode choice behaviour. The characteristics that have been captured from our survey are the following.

4.2.1 Demographic characteristics

Demographic characteristics aim to gather simple and basic, but yet critical information about the population sample that participated in the survey. So they include classifiable characteristics of the given population. Demographic characteristics help us know our users better and allow us to classify their characteristics based on some demographics commonalities that they might have. The demographic profile of a user consist of the following information:

- **Nationality**- Nationality affects the cultural differences users might have.

- **Age** -Age has a major effect on users' behaviour. Users' need change as they grow older. Age leads to changes in personal values, lifestyle, transportation needs and UI requirements.
- **Gender** - Males and females have entirely different needs and preferences that affect their selections of lifestyle products and fashion.
- **Education** - The level of education influences users' perceptions of the things around them and affects the degree of research before making a decision.
- **Employment status** - The respondent's occupation plays a major role in the mode type they choose to use. Their jobs give insights into the type of person they are.
- **Income** - Income has a significant effect on users' behaviour and mode decisions. Middle-income users consider high utility of money while buyers with higher incomes prefer luxury items, vacations, jewellery and expensive cars.
- **Living arrangement –** The living characteristics of users affect their decision mind-sets.

4.2.2 Physio-Characteristics

Physio-characteristics concern the physical bodies of people, the way that they use their bodies and how their bodies exist in physical environments. Traditional human factors research has often concerned itself with the physio-characteristics of products (e.g. automotive ergonomics), but traditionally. The most important physio-characteristics aspects that should be taken into account are briefly outlined below.

- **Special disadvantages –** Special disadvantages concern the chronic conditions that leave people either permanently or temporarily at a physical disadvantage. Obvious examples include physical handicaps such as blindness or deafness, but might also include the effects of age.
- **Urbanisation and physical environment -** People always operate in a specific physical environment that includes ambient light, sound, temperature, etc. Regarding transport their urbanisation status is important regarding the availability of specific modes.

4.2.3 Ideo and socio characteristics

People prefer to use products that they believe reflect their own personalities, understanding the attributes of self-image seems paramount in the design process. Additionally, socio characteristics are also important since they reveal the ways that people relate to others and how individuals fit within social groups. Socio-characteristics also include self-images through which people define their identities with or against certain groups of people. Ideo-characteristics, much like the socio-characteristics, speak to the way we view the world and how we choose to operate in it. Our value sets, which derive from our membership in communities of various types, impose themselves upon how we interact with products and how we expect products to be constructed. Consequently, this approach examines not only people's actions reveal their memberships and relationships, it also considers a person's perceived (or desired) personal and social status. Ideo and socio-characteristics in our study involve the following elements:

- **Lifestyle –** This attribute refers to the way people live their lives. The lifestyle status, isn't only related to material wealth, but can include cultural status such as being seen as "cool", "active" or "classy". For example, some people may choose to live environmentally conscious lives and enjoy being outdoors. Others may prefer a more industrial and urban lifestyle. Information products designed for each audience might differ, for example, in colour palettes and the language might be more reflective for the environmentalist and perhaps more terse for the car addict.
- **Personality traits -** This set of characteristics concerns relatively stable attitudes that comprise a person's overall personality, not momentary moods or states of arousal. Users' personality traits have been gathered using a short version of the BIG five inventory (John & Srivastava, 1999)and specifically the BFI-2 (XS) (Lang, John, Lüdtke, Schupp, & Wagner, 2011) in combination with the regret and disappointment scale (Marcatto & Ferrante, 2008). What is important is to connect these personality traits to respondents' mode selections.
- **Personal ideologies -** Ideologies, although often unconscious, serve as a basis for many of the decisions we make in our daily lives. Personal ideologies outcomes are based on literature user profiles. Is the user an "aspiring environmentalist" or a "die-hard driver"?

5 Conclusions

Human choice behaviour can be perceived as a mental process that transforms perceptions of several options into a choice. Functional analysis of choice human behaviour can provide a framework model to which concrete assumptions about the choice process could be attributed from economics and other social sciences. There are a lot of theories that have been used to model issues related to transport choices. In this paper, we focus on the commute trip and specifically to the mode choice of commuters.

After having reviewed most of the theories related to choices, Utility Theory, Prospect Theory and Theory of Planned Behaviour and the ways that are used to extract and predicts the user choices, we have developed a Discrete choice experiment in order to find out which factors are affectiving commuters mode choices.

The Discrete choice experiment was realised using a Stated Preferences Survey. In order to create a concrete framework for our Stated Preferences Survey, we conducted a focus group in Athens with 10 participants. The data collected from the focus group were incorporated into the stated choice experimental design to create a realistic choice situation for the survey participants. Based on the information selected from the focus groups one hypothetical scenario was presented to the survey. The initial choice problem was related to the users' commute trip. Thus, the users were asked about their habitual commute trip and they had to choose between a set of alternatives (car, bus, train, bicycle) in different eight different choice sets (different alternative levels for each choice set).

The list of alternative modes of transportation that could be used for commuting is quite long, and includes at least 15 alternatives. For the SP survey, a universal but finite list of all the existing alternatives had to be compiled. So it was decided to use a set of four alternatives which were extracted from the focus group discussion. This set of transportation mode alternatives that was used in the choice experiment includes, the car, the bus, the train which incorporates the light train, the train and the metro and the bicycle. Moreover, the focus group discussion revealed that the distance covered from the user was so long that it was not feasible to be realised on foot. Each of the attributes was described by a number of levels. The attribute levels were decided upon using a mixed approach, by blending the data extracted from focus groups and optimizing them with information from previous research projects that yielded results with high validity.

The attributes organized by alternative as well as the selected attribute levels have been used to define the experimental design of the choice experiment which was created using Ngene, a software that is distributed by ChoiceMetrics (www.choicemetrics.com). The actual SP survey is consisted by 16 different scenarios, divided into two groups of 8. Using an SP survey, the respondents are expected to choose the alternative that maximizes their net utility and select the mode alternative that provides the highest utility for them. The data that will be retrieved from the SP survey will be analysed using an MNL and a mix logit model focusing on the systematic component of the utility function.

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