Alma Mater Studiorum – Università di Bologna

DOTTORATO DI RICERCA IN

PSICOLOGIA

Ciclo XXXII

Settore Concorsuale: 11/E3

Settore Scientifico Disciplinare: M-PSI/05

SUSTAINABLE MOBILITY IN COMMUTERS: PSYCHOSOCIAL FACTORS AND MODE CHOICES

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Esame finale anno 2020

Acknowledgments

*To all the **colleagues** and **professors** met in this long, intriguing and fascinating journey of personal and professional growth.*

*A unique and immense thanks to professor and mentor **Luca Pietrantoni**, the only real reason why I wanted to take up this challenge*

*To all my **friends**, especially those are no longer here, but who are still with me, in my mind and my heart.*

*To my **family**, and to my **mother**, who has always been by my side, watching over me, whatever decision I made.*

*To **my love**, because without her, it would have been dramatic You're the perfect half of me that makes me complete.*

"*If the only tool you have is a hammer, you tend to see every problem as a nail*."

Abraham Maslow

Abstract

Climate change and the need for taking an urgent action against it are two tightly related factors strongly characterizing the current global society. Car use and the increasing reliance on cars among people, its effects in terms of societal costs, traffic congestion and road accidents are considered a significant contributing factor to climate change. Promoting a behavioural shift towards a sustainable mode of transport is considered as a crucial strategy to ensure both a better quality of life for actual generation and a clean and sustainable environment for future generations.

This dissertation investigated psychologically, how people can best be supported in understanding their modal choice and who policymakers and relevant stakeholders can be supported in handling this challenging with substantial and relevant actions. Since people handle their travel behaviours differently (e.g., depending on their attitudes, values as well as location or the environment where they live), this dissertation followed a human-centred approach to provide additional knowledge on users' needs, perceptions and decision-making processes. Four studies on psychosocial and behavioural aspects have been conducted among academic commuters, using multiple methods and approaches. The main aim was to deepen the understanding of psychosocial factors and their relationship with situational and environmental characteristics in influencing the commuting modal choice which can be of help in crafting tailored and diversified interventions, both at organizational and policymaking level. In light of the present dissertation findings, a multidisciplinary approach seems to be essential. Indeed, a traffic management system, even if technically perfect, could not reach satisfactory standards if it is not esteemed based on users' perceptions, motivations, social and built environment, travel behaviour reasons and preferences. In line with this perspective, this thesis contributed to understanding the role of psychosocial factors in mode choices and travel behaviours.

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Chapter 1. Introduction

Climate change and the need for taking an urgent action against it are two tightly related factors that are strongly characterizing the current global society. The importance of these two topics is further witnessed by the seventeen Sustainable Development Goals (SDG) of the 2030 UN Agenda for Sustainable Development (United Nations, 2015), in which it is clearly stated the need to urgently take action against climate change and its negative consequences (i.e., 13th Sustainable Development Goal). Among the topics addressed at political level, the use of the car is one of the factors linked to the negative consequences for the environment. Indeed, car use is considered a factor to air pollution and long-term climate change (Collins & Chambers, 2005; Wall, Devine-Wright, & Mill, 2007). Collins and Chambers note that "*personal car use contributes to environmental pollution, decreased air quality, greenhouse gas emissions, and fossil fuel consumption.*" (p. 640). Moreover, the increasing reliance on cars among people raises concerns about human sedentary lifestyle and its adverse effects on health (Gärling & Friman, 2015) which can be particularly harmful to older adults. Finally, car use is strictly related to the societal costs derived from traffic congestion, road accidents and injuries (Albertsson & Falkmer, 2005).

The Brundtland Commission introduced in 1987 a general definition of sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. By transferring this concept to transport research, the main aim is to identify and deepen the knowledge of the nowadays antecedents that better incentive the use of sustainable modes of transport to ensure that future generations can experience a clean and sustainable environment. Within this line of research stands the 2030 Agenda for Sustainable Development declared by the ONU which, among the various claimed objectives, wants to ensure access for all to a safe, affordable, accessible, clean and sustainable transport system, improving road safety, with particular attention to the needs of

the most vulnerable ones as women, children, people with disabilities and the elderly. A way for facing such urgency is to promote and induce people to use sustainable modes of transport since the abuse of the unsustainable ones represents a consistent contributor to climate change (Lo, van Breukelen, Peters, & Kok, 2013).

In this perspective, a human-centred approach has been suggested to explore under which personal and external conditions (e.g., situational, infrastructural, geographic, economic), a modal shift is likely to occur. Promoting the decarbonisation of road transportation through more efficient and greener mobility is a challenging task that can be achieved by well-designed behaviour change programs and organizational interventions. Although the road transportation policies adopted in Europe have led to some improvements, substantial challenges remain, and more significant impacts on health and environment still need to be achieved. The success of initiatives in reducing personal car use through behavioural change will mostly rely on the ability to persuade the community to use public or active modes of transport, especially for commuting (Van Acker, Goodwin, & Witlox, 2016).

A critical area where to concentrate attention and resources is commuting behaviour. Considering that in 2014 transport emissions were responsible for 23% of global CO2 emissions (Wang & Zeng, 2019), our choice of mobility to reach our work/study location is one of the main factors contributing to urban traffic and daily urban CO2 emissions. Indeed, according to a recent European report (Focas & Christidis, 2017), urban mobility accounts for 40% of all CO2 road transport emissions. Recent revisions have focused on identifying the critical antecedents of unsustainable modes use across disciplines (De Witte, Hollevoet, Dobruszkes, Hubert, & Macharis, 2013; Frank, Bradley, Kavage, Chapman, & Lawton, 2008). A significant amount of empirical evidence has been published on the role played by psychological factors (Donald, Cooper & Conchie, 2014; Gardner & Abraham, 2008) or the presence of mobility constraints that may discourage or promote car use (Kim & Ulfarsson,

2008; Whalen, Pàez, & Currasco, 2013; Zhou, 2012). In addition, aspects related to human factors such as comfort and perceived safety during travel or the level of infrastructure have been seen to play a role in the modal choice, particularly in the economic value given to one's time spent on travel and the general satisfaction of one's routinely (De Vos et al., 2016; Kouwenhoven & de Jong, 2018; Ye & Titheridge, 2017).

The present dissertation focused on deepen and expanding the knowledge on psychosocial factors which have an impact on commuting modal choice among an academic community. The academic setting holds a crucial role in reinforcing or reshaping both university community behaviours and awareness with the chance to develop new sustainable habitual mobility patterns and produce good organizational practices for the community at large (Zhou, 2012). In other words, promoting a behavioural shift towards a more sustainable path is not only a matter of social responsibility and institutional sustainability goals (Whalen et al., 2013) but it would be beneficial for the university itself, also in terms of personal and organizational well-being (Page & Nilsson, 2016). Indeed, since students and employers that belong to the university tend to live and reside close to it, every step made towards sustainable mobility will help establish a good example for the academic community and the city at large (Whalen et al., 2013). Not surprisingly, universities are seen as dominant trip generator (Khattak, Wang, Son, & Agnello, 2011), therefore even the slightest change in terms of mobility behaviour might have a significant impact at aggregated level (Zhou, 2012). Within this scenario, universities can take the opportunity to provide leadership in the field of sustainable transportation (Balsas, 2003), acting as advocates and front-runners in developing and improving policies and infrastructure that foster a behavioural change towards more sustainable mode of transport (Dagiliūtė, Liobikienė, & Minelgaitė, 2018).

The first chapter of this dissertation introduces and describes the modal choice from a theoretical point of view. Main factors that influence own's mobility behaviour are presented

and highlighted with the intent to outline recent developments in sustainable mobility research. Aside from highlighting the complex nature of this field of research and the interdependencies between psychological, social, as well as environmental and economic factors, the chapter concludes by highlighting the research questions and the main objectives of the four studies conducted.

The following four chapters (chapters 3, 4, 5, 5, 6) represent each of the studies carried out in which methods, measures, statistical analyses, results and discussions are reported. The studies focused on psychosocial and behavioural aspects of commuter mobility using multiple methods and approaches. The first and the second study analysed psychosocial, attitudinal and environmental predictors of modal choice at different distance threshold, thus defining commuter groups. The third study investigated perceived constraints, barriers or triggers in the decision-making process of modal choice from a qualitative approach. The fourth study investigated the value of time (VOT) from a psychosocial perspective. The results enriched current knowledge on commuter behaviour to support researchers and policymakers in developing strategies and incentives to promote behavioural change towards environmentally friendly modes of transport. Indeed, the last chapter concludes by discussing the results of the four studies and giving an outlook for future research

1.1 Travel behaviour: theoretical frameworks

1.1.1 Rational Choice Theories

The influence of psychology on transportation research is not new. Already in the 1970s attitudinal theory developed in social psychology had an impact on travel behaviour analysis and research. In those years, the relevant literature was mainly rooted in the concept of an entirely rational man in his daily choices. These choices also included decisions in terms of modes of transport. The underlying idea behind the Rational Choice Theory (RCT, see Becker,

2013) consisted of a person continually seeking to maximise their utility by calculating, time after time, the costs and benefits of the various alternatives available. In this regard, the modal choice that would allow maximize the benefits while minimizing costs and efforts becomes the ideal choice. In other words, the term "rational" refers primarily to two fundamental aspects. The process by which the individual reaches his final outcome and the goal itself (i.e., maximization of personal utility), is what is meant by rationality. In all this, the (psychosocial) efforts required to achieve the result are not taken into account. Likewise, the ability of the individual himself to achieve a broad understanding of the various alternatives, in terms of pros and cons, is not questioned. In other words, a high individual monitoring and calculation capacity is taken for granted, based on which, given a choice with the greatest perceived usefulness and the least disadvantage, a final decision is made.

Although RCT has characterised the modelling and planning of conventional transport, it has not been without criticism. The principle of limited rationality and the maximisation of personal satisfaction (rather than its usefulness) are only two of the points that have emerged as critical. The theory of rational choice has lost credibility in those scenarios because of another aspect. The theory does not consider the certain degree of uncertainty concerning the expected outcome (for example, the choice of a road route whose degree of traffic congestion and hence the time of arrival is unknown). Kahneman and Tversky (1979) thus proposed the Prospect Theory (PT) as an alternative model to describe how people make decisions even in a context of uncertainty. The basic idea is that people prefer alternatives of choice where the gains, and especially the losses, are clear and explicit. In other words, when faced with selecting the mode of transport, people are more inclined to choose the option that minimizes risks and losses in a known scenario. Where the choice of means of transport is optimal but in an unknown or unpredictable context, people will move towards the more familiar option which may be less useful but more reliable in terms of gains and losses.

As a result of these rational perspectives, strategies aimed at shifting the modal choice, the monetary prices of the various means of transport were considered as determining factor for the individual choice of travel. Therefore, private car users could be economically convinced to continue using the car because it represented a certain economic status or to adopt more environmentally friendly public transport by pushing the "price" element (e.g., reductions on monthly tickets for public transport...). The underlaying assumption was that, given the evident savings in economic costs, people would choose the one that was most convenient for them. However, research at the time showed that simple price and income factors did not have a significant effect on people' transport behaviour (Hensher & Dalvi 1978; Diekmann & Preisendoirfer, 1998). At the same time, these studies showed that additional factors such as travel time, socio-economic and socio-demographic characteristics (e.g., as age, family size, gender, professional status) had a strong influence on personal modal choice. To explain why one mode of transport was preferred to another, it seemed that there was a scenario defined exclusively by monetary costs and revenues. Criticism of the economic approach in explaining people's travel behaviour made it possible to underline the predictive power of motivations, norms and personal values and based on sociological characteristics that can explain the variation in transport preferences, rather than based on the differences given by each person's financial capacity.

It is within this framework that research studies based on psychological and sociological angles in the field of transport mobility have been developed. Among these perspectives, Ajzen's Theory of Planned Behaviour (TPB, 1991) and the Norm Activation Model by Schwartz (see 2012) were later found to be the most widely recognised in targeting determinants of car use or changes in using the car.

1.1.2 Psychosocial theories: Perceived behavioural control and personal norms

One of the objectives of traffic psychology has been to explore and understand stable and defined overarching mobility behaviour patterns shaped by relatively stable intentions, attitudes, norms, or socio-demographic factors (e.g., Bamberg & Schmidt, 2003; Hunecke, Blöbaum, Matthies, & Höger, 2001). One of the most influential and well-documented models in the literature is the Theory of Planned Behaviour (TPB; Ajzen, 1991) which can be seen as an extension of the Theory of Reasoned Action. Early adopted by transport researchers (Gärling, Gillholm & Gärling, 1998), the TPB (Figure 1) describes how personal intention lead to the implementation of a specific behaviour. In other words, the theory considers the behavioural intention to be the immediate determinant of the corresponding behaviour (e.g., behavioural intention to reduce car use).

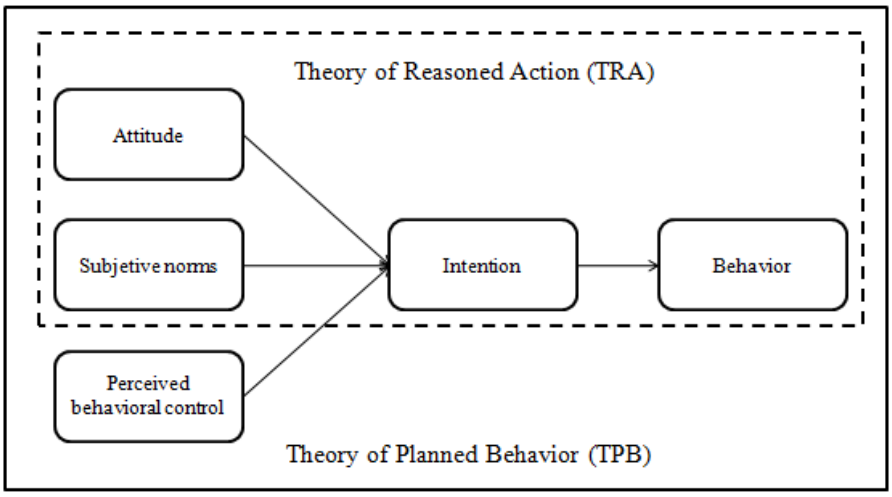

Figure 1. *The Theory of Planned Behaviour (Ajzen, 1991)*

The underlying assumption is that the intention to engage in a particular behaviour is the expression of the personal motivations underlying the behaviour itself. In other words, the intention can be considered as an indicator of how much people are willing to engage, spend energy and resources to perform the specific behaviour. If intentions are strongly related to behaviour and intentions can be predicted in some way, then future behaviour can also be predicted.

One of the reasons why the TPB has been very successful is because of the straightforwardness of the model which combines the rational part, namely calculating possible alternatives, with an attitudinal part, i.e., the intention to adopt a particular behaviour. At the core of the model, there is a rational process underlying the sequence from beliefs to behaviour. Individuals systematically consider the entire process and use the information available to reach a final decision and initiate the behaviour. The model itself works as a series of hypotheses linking behaviour to intentions, intentions to attitudes, norms and control, and these components to behavioural, regulatory and control beliefs. In conclusion, the TPB relies on its inclusive and economic structure which can explain mobility behaviour and mode choice (Hunecke, Haustein, Grischkat, & Böhler, 2007). The intention is determined by the personal attitude towards the behaviour, the subjective norm concerning the behaviour and the perception of being in control of the specific behaviour. The attitude towards the behaviour refers to the evaluation that the person makes of that particular behaviour (e.g., positive or negative). If the person has negative attitude towards reducing car use, it will be challenging for the person to implement this behaviour. The subjective norms refer to the degree that the others, people closest to us, consider such behaviour as positive or negative. If the people closest to us explicitly encourage a reduction in the use of the car, the person will feel a higher pressure (and therefore a more significant push) to implement the given behaviour. The perception of control over one's behaviour, on the other hand, represents the consideration of oneself in being able to implement a given behaviour. If the person believes that he or she has the skills and abilities to implement a given behaviour, he or she will be more likely to act accordingly.

As far as commuting to work is concerned, for example, people will use a sustainable mean of transport if they see it positively, perceive a social pressure to do so and feel to have the opportunities and skills to do so. The latter point is crucial in differentiating the TPB against

the previous model since it stresses the significant influence of situational constraints or perceived barriers to the behaviour (Anable, 2005). Viewed in this way, the impact of PBC is regulated by both infrastructural characteristics and the built environment, as well as by living conditions and personal circumstances (Hunecke et al., 2007). A person will be more willing to engage in a specific behaviour if the attitude towards it is positive and if the context is favourable. A study from Bamberg, Rolle & Weber (2003) demonstrates this hypothesis by manipulating the contextual factors influencing the commuting behaviour. A comparison between the subject who receive a free public transportation pass, maps and information about the public transport system and the control group showed higher levels of public transport use by those subjects under contextual manipulation.

Several studies provided strong empirical support for the TPB model in the field of transport mode choice, especially the crucial role played by the perceived behavioural control (PBC) in shaping mode choice (e.g., Bamberg, Hunecke, & Blöbaum, 2007; Bamberg & Möser, 2007; Donald, Cooper, & Conchie, 2014; Gardner & Abraham, 2008), particularly over commuters travel-mode choice. A recent systematic review with meta-analysis (Hoffmann, Abraham, White, Ball & Skippon, 2017) highlighted the most robust correlations of mobility choices on intentions, perceived behavioural control and attitudes. For example, favourable attitudes towards alternative transport modes turned out to be negatively associated with private vehicle use which represents the urban mode of transport with the highest nitrogen oxide emissions (Hill, Bonifazi, Bramwell, Karagiami, & Harris, 2018). In terms of attitudes, while flexibility emerged has one of the predictive factors of car use, convenience significantly influenced the intention to use public transport (Simsekoglu, Nordfjærn, & Rundmo, 2015). Furthermore, Abrahamse, Steg, Gifford, & Vlek (2009). For example, the perceived safety of the means of transport, their convenience, the temporal flexibility guaranteed by each of them or their practicality, the beneficial effects on health or the risk of being involved in an accident

as well as the comfort experience along the trip. have been analysed as antecedents of the attitudes towards different modes of transport (e.g., Şimşekoğlu, et al., 2015).

Parallel to the TPB, a remarkable line of research based is assumption on the role of individual values and social norms. In other words, individual attitudes, subjective norms and the PBC were considered as the products of beliefs and motivations. Even though the TPB assumption is that behavioural intention is determined exclusively by attitude, subjective norm and PBC, research has shown that intentions and pro-environmental behaviours (e.g., car use reduction) are influenced by other factors not contained in the model, such as moral and descriptive norms (Stern & Diez, 1994).

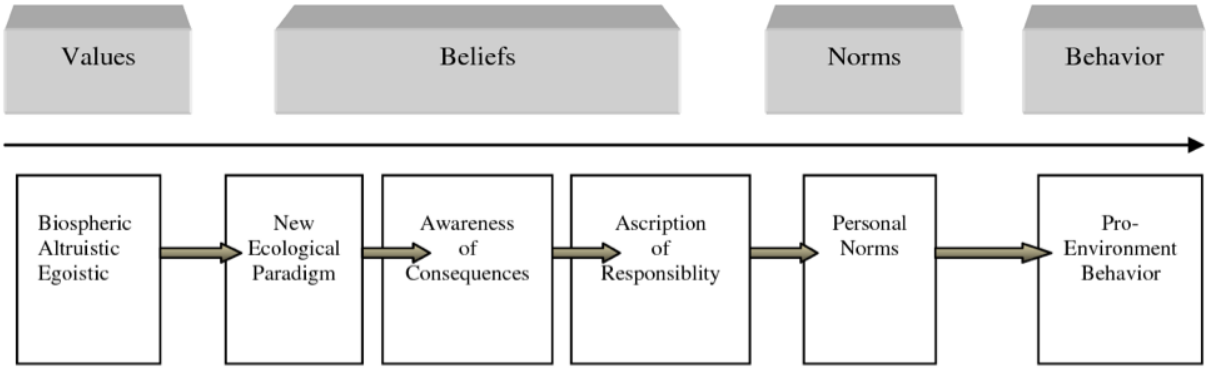

Figure 2. *Value-Belief-Norm (Stern, 2000)*

Indeed, the Norm Activation Model (NAM) proposed by Schwartz (1977) focus on the normative influences on the behaviour. The NAM model has been further extended by the Value-Belief-Norm (VBN, Figure 2) proposed by Stern (2000) which combined the NAM with the New Environmental Paradigm (NEP; Dunlap, Van Liere, Mertig & Jones, 2000) and the Value Theory (see Schwartz, 2012). The VBN model postulates the crucial role played by a personal feeling of moral obligation that might triggers and drives the behaviour such as choosing environmentally modes of transportation. More in detail, the model postulates a chain of values and beliefs referring to the desired goal, which in turn activates a pro-environment

behaviour (Figure 2). As stated by Schwartz (2012), a value can be defined as a guiding principle in a person' life which indirectly affect behaviour.

Initially, researchers have been focused on exploring the impact of personal values (i.e., biospheric, social or altruistic, egoistic, hedonic) in engaging in pro-environmental behaviour. Besides, by applying the New Ecological Paradigm Scale (NEP, Dunlap, et al., 2000), studies tried to highlight the relationship between personal environmental concern and behaviour. A general concern about the environment should affect specific and individual beliefs which in turn will activate a personal moral obligation in behaving coherently. The next line of research introduced two crucial individual factors necessary to activate the norm, the personal awareness of the consequence (AC) of one own's action and a personal belief over the capacity to prevent the harmful consequences of such conduct (ascriptions of responsibility or AR).

Several studies provided support to the VBN theory in predicting the different type of sustainable behaviours. About the choice of mode of transport, a hierarchical model elaborated by Nordlund and Garvill (2003) showed the impact of personal values and problem awareness on personal norms which in turn influenced the intention to reduce personal car use. Similarly, De Groot and Steg (2009) noted that participants with a high AC and AR regarding the need to reduce car use, are those who showed a deep sense of moral obligation to act accordingly and therefore more willing to accept policies that would increase the costs associated with car use. A study conducted in Argentina (Jakovcevic & Steg, 2013) based on the VBN theory, has adequately highlighted the predictive effect of AC, AR, biospheric and hedonic values in triggering regulatory considerations that in turn activate the intention to reduce car use and the willingness to accept a new transport pricing policy. A study from Lind, Nordfjærn, Jørgensen, and Rundmo (2015) examined the determinants of environmentally transport behaviour based on the VBN. After clustering participants into three different groups of transport mode – frequent users of car, frequent users of public transport, and frequent users of active mode of

transport (i.e., walking and cycling) – through a structural equation model analysis, the authors highlighted the importance of values and beliefs which explained 58% of the variance of transport behaviour.

However, in recent years normative models have been criticised since it appeared to be a more useful model when predicting and explaining pro-environmental behaviours that require a low cost or effort (Steg & Vlek, 2009). In a setting characterized by high behavioural costs (e.g., reducing car use), the TPB appears as a more robust model (Bamberg & Scmidt, 2001). One of the main reasons is that not all individuals actively embrace pro-environmental norms and values, a condition that would seem to be necessary to facilitate a change in mobility behaviour in the direction of sustainability. Moreover, it is not guaranteed that such values, even if possessed, are translated into behaviours (i.e., value-action gap). As highlighted by Verplanken, Aarts and van Knippenberg (1997), for this to happen, two conditions must be met: (1) the values must be central to the individual's concept of self; (2) values must be cognitively activated. Finally, in countries with opposite or different social and environmental values (e.g., Western vs Eastern countries), the VBN has been found to lose its predictive value (Nordfjærn & Zavareh, 2017).

Concurrently, few studies tried to compared or combined variables from the TPB and NAM to overcome the critics and identify the main factors affecting car use or the intention to use alternative modes of transport. Bamberg and Schmidt (2001) found no significant relationship between personal norm and the intention to reduce car-use when considering the TPB factors. In contrast, Abrahamse, Steg, Gifford, and Vlek (2009) showed that car choice for commuting was mainly explained by perceived behavioural control and attitudes, while personal norms explained the intention to reduce car use. Another study by Liu, Sheng, Mundorf, Redding and Ye (2017), found that TPB variables and personal norms are crucial dimensions in predicting the intention to reduce car use, with the normative dimension

exhibiting a weaker relationship with the dependent variable. A study from Doran and Larsen (2016) showed the crucial role of personal norms in explaining a relatively large proportion of variance for eco-friendly mode choice. The results are supported by other studies that underscore the relative importance of a personal feeling of moral obligation in reducing car use (Nordlung & Garvill, 2003; Bamberg et al., 2007). Recently, a recent systematic review with a meta-analysis (Hoffman et al., 2017) supports these results highlighting larger average effect sizes of TPB variables (i.e., perceived behavioural control, intentions, and attitudes) than measures of norms.

One of the main fault of the two models is that neither of the models adequately represents behaviour patterns that may be regulated by less conscious processes, especially in case of repetitive and habitual behaviours such as car use (Klöckner & Blöbaum, 2010; Sniehotta, Presseau, & Araújo-Soares, 2014), or commuting trips. In other words, considering the daily mobility behaviour that tends to occur in a stable context, commuter mode choice may be considered as a habitual response to a stable environment with no conscious deliberation rather than a rational choice (Gardner, 2009; Gärling et al., 2015; Verplanken et al., 1997). In order to develop and structure effective interventions, research has been focused on exploring and investigating the role of habit in the modal choice that could highlight which area needs to be stressed and where to intervene in order to promote a behavioural change.

1.1.3 Habit Discontinuity Theory: the role of Habit in travel behaviours

A habit can be defined as an automatic response, learned by repetition, under constant circumstances of a motivated action to attain a specific goal (Verplanken el al., 1997). Although this concept is rooted in behaviourism, building a habit is a cognitive-motivational process in which control of the action relies on the environment (Wood & Rünger, 2016). Considering all other factors being equal, the more a behaviour is rewarded, the more likely it will be repeated when a specific contextual stimulation is present (Klöckner, 2013). Accordingly, in a study by

Verplanken et al., (1997) participants were asked to choose their mean of transport for different destinations, and it emerged that people with a vigorous habit towards choosing a specific travel mode, the decision-making process involved less elaborate choice strategies. Also, when the authors compared the decision-making processes of participants with a solid car-use habit (or bicycle-use habit) to other participants with a weaker car-use habit, the former considered less alternative option, collected less information and looked for information that would have confirmed their habitual modal choice. This phenomenon, also known as "*tunnel vision* ", may penalize a person as it could prevent from noticing essential changes occurring in the context. For example, if one had a strong habit using a car to go to work, even feeling responsible for using the car and its negative consequences for the environment may not be sufficient to make the person aware of new and efficient public transport lines or of a more sustainable and cheaper way to reach the workplace. In other words, the person will continue to use the car while being aware of the unsustainable mode. Indeed, Lind et al. (2015) found that feeling responsible for using the car and the following negative consequences were not enough to undermine the decision to use this unsustainable mean of transport for daily trips.

Similarly, a study by Schuitema, Steg and Vlek (2007) showed that, despite the rising costs of driving a car, regular car users had no intention of changing their mode of travel. A plausible explanation could come from the automatic processes of using the car. In general, the stronger the habit, the less is the impact of the intention to change a specific behaviour (i.e., car use reduction). For example, when a person tends to use a car in his/her home-work trip, a car use habit is likely to develop for this specific route which makes the person resistant to adopt other travel mode alternatives even if the intention to change is high.

Several psychological studies showed the critical role of habits in determining travel mode use, including car use (Bamberg et al. 2003; Gardner et al. 2008; Klöckner & Blobaum, 2010; Şimşekoğlu et al., 2015; Verplanken & Roy, 2016). Indeed, it is well recognized that

understanding the principal predictors of car use is not adequate without investigating the car use habit (Şimşekoğlu et al., 2015). As mentioned above, the main reason is that strong car use habit is the result of successful and repeated past behaviour, i.e., people's travel mode choices are strongly influenced by past trip behaviour (Kerr, Lennon & Watson, 2009). In general, commuters are more likely to behave as usual, relying mainly on cars as they interface with a predominantly stable environment (Abou-Zeid, Witter, Bielaire, Kaufmann, and Ben-Akiva, 2012; Friedrichsmeier, Matthis, & Klöcker., 2013; Gardner, 2009). Indeed, recent study also reported that measuring frequency of behaviour in the past is an adequate measure of habit (Chen & Chao, 2011). Accordingly, Aarts and Dijksterhuis (2000) developed a scale devoted to accurately measure habitual choices, more specifically, to highlight how a routinely choice is made and the Response-Frequency Measure (RFM) has been successfully adopted in previous research on sustainable and environmental behaviour (Klocker, Matthies, & Hunecke, 2003).

From a behavioural change perspective, it can be argued that once car use has turned into habitual behaviour, it might be challenging to break the habit and persuade car user to reconsider his/her mental model and use alternative travel mode options. Identifying interventions capable of breaking habits may, therefore, be as important as deploying winning interventions targeting motivation. Consequently, it may be reasonable to think that habits are only reconsidered when there is a significant change in context. For instance, a series of studies by Verplanken and colleagues (Verplanken et al., 2016; Walker, Thomas, & Verplanken, 2015) into the habit discontinuity hypothesis have demonstrated how contextual changes, for example, moving home or offices, can weaken habits and create "a window of opportunity" where people can redefine their mobility pattern and embrace a behavioural change. Concerning the mobility domain, literature has explored the effect of discontinuities planned by individuals, such as the change of residence (Verplanken et al., 2016), but also unexpected

ones, such as road closures (Fujii, Gärling, & Kitamura, 2001). Besides, the event may involve a lasting change, such as the relocation of a company's headquarters (Walker et al., 2015), or temporary, such as a wrist fracture (Musselwhite et al., 2016). Fujii et al. (2001), for example, studied the effects of a temporary closure of a ring road on a sample of commuters who usually use their cars to get to their workplaces.

Similarly, Brown, Werner and Kim (2003) found that a temporary lack of parking at the University had led some motorists to opt for the light rail and, for some of them, this mobility behaviour has become a long-term choice. A permanent or temporary structural change would, therefore, seem to induce a long-term behavioural change. However, this has been partly contested by Walker and colleagues (2015), who have carried out a longitudinal study aimed at deepening the process of breaking habits. One month after the WWF headquarters moved, the workers still exhibited the old, albeit weakened, mobility habit. Discontinuity creates a temporal window in which people are vulnerable to change if external stimuli also support this. Since the old habit is not extinct, in the presence of adequate environmental stimuli, the person could return to exhibit the past ordinary behaviour.

1.1.4 Towards a Comprehensive Model: the role of Situational influences and Environment characteristics

In this scenario, Klöcker and Blöbaum (2010) introduce a comprehensive model (Comprehensive Action Determination Model, CADM) in which the previous determinants of car use (e.g., TPB, VBN) are considered together with the role of habit as well as situational constraints and characteristics of the built environment. The model (Figure 3) includes the effects of normative processes (i.e., norms and beliefs), intentional processes (i.e., attitudes and intentions), iterative processes (i.e., habits) and situational effects on mobility behaviour (ecological behaviour). In this model, the main assumptions from TPB and NAM are combined with the concept of habit. Moreover, aspects that are related to the ipsative theory of behaviour

are introduced, which offers an exciting perspective on the importance of situational influences. As far as the latter is concerned, the theory argued that objective and subjective constraints mainly determine behaviour. The former is related to the environmental aspects which may constraints or facilitate the adoption of a specific ecological behaviour. For example, a person embedded in a high-quality infrastructure neighbourhood with separated cycle path might be more prone and feel more confident in choosing the bike for his/her movements. Subjective constraints, instead, are related to those situational circumstances in which the individual lives that have an impact on the modal choices available (e.g., owning and having access to the car). In terms of subjective constraints, the model also includes a person's perceptions of their ability to perform a behaviour, a concept which reminds to the PBC.

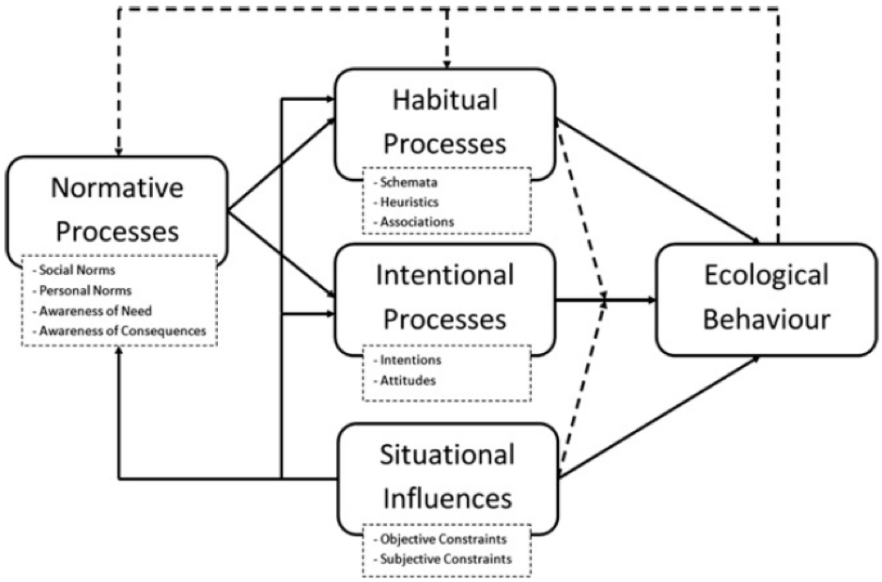

Figure 3. *Comprehensive Action Determination Model (Klöcker & Blobaum, 2010)*

CADM has been confirmed on a practical level, thus showing the benefits of adopting an integrated approach to the study of travel behaviour. The model's variables predict up to 65% of the variance. Results highlighted the primary role played by situational influences, both objective and subjective (Klöcker & Blöbaum, 2010). Next, Klöckner and Friedrichsmeier

(2011), adopting a multi-level approach to identifying the determinants of car use behaviour, further confirmed the importance of both individual and situational factors.

Recent reviews have focused on identifying the crucial antecedents of car use across disciplines, especially about travel mode choice, and much empirical evidence has been published regarding the situational and environmental influences that may discourage or promote the use of the car (De Witte et al., 2013; Frank et al., 2008). For example, several studies have highlighted the role of travel time (Zhou, 2012), distance to cover (Nordfjærn et al., 2017), travel cost (Anable & Gaterslebem 2005), accessibility (Hunecke et al., 2007; Handy, Cao, & Mokhtarian, 2006), comfort (Heinen, Maat, & Wee, 2011), local transport conditions (Fosgerau, Hjorth, Brems, & Fukuda, 2008), spatial characteristics (Kim & Ulfarsson, 2008), and car access (Klöcker & Blöbaum, 2010).

For example, car access has been found to increase car use and at the same time, to reduce the reliance on public transport (Klöcker & Blobaum, 2010; Pinjari, Pendyala, Bhat, & Waddell, 2007; Santos, Maoh, Potoglou, & von Brunn, 2013). It is not surprising that the simpler the access to a car, the higher the likelihood to effectively use the car. Nevertheless, it has been found that car access could be considered more as a binding constraint of travel mode choice rather than a critical factor that prompts car use (Klöckner, & Friedrichsmeier, 2011). Other studies showed that males use car more than females (Bergstad et al. 2011; Polk, 2004) and, in general, males tend to exhibit a stronger car habit (Matthies, Kuhn, & Klöckner, 2002) which in turn leads to a higher use of the car in their commuting trip. Moreover, recent studies have highlighted that car use trends have been significantly decreasing among the younger generation, especially among males (Delbosc & Currie 2013; Kuhnimhof, Buehler, Wirtz, & Kalinowska, 2012). A remarkable study from Prillwitz and Barr (2011) found significant differences based on age and gender, thus supporting existing findings. The authors clustered their sample based on the number of trips made by different modes of transport. Results

highlighted that female and people with lower income were more willing to use public transport, whereas "consistent green travellers" were younger than participants in the other groups. On the other hand, studies also found that people with higher income are more willing to use the car (Chen, Gong, & Paaswell, 2008).

Additionally, commuting distances have been found to affect car use. The longer the distance, the higher the tendency to use the car (Lind et al., 2015; Loukopoulos & Gärling, 2005; Zhou, 2012). Indeed, if the trip length is considered as one of the significant determinants for using the car, the accessibility to other modes of transport may be critical to behaviour change (Hoffmann et al., 2017). For example, several studies have found that people, especially commuters who live outside the urban area with limited access to public transport (or other types of sustainable transport services), are more willing to use the car for their trips (Dargay & Hanly, 2007; Mann & Abraham, 2012). Likewise, within this perspective, population density has been used as another type of infrastructural determinants which can explain mode choice (Susilo & Maat, 2007) and car use (Dargay & Hanly, 2007). The rationale behind is that the higher the population density, the higher the likelihood to use an alternative and sustainable mode of transport due to a high traffic density, low travel speed, and better accessibility of public transport (Chen et al., 2008; Santos et al., 2013). For example, Kim and Ulfarsson (2008) provide evidence that short automobile trips are observed more often in less urbanized areas (i.e., with lower density population), compared to short bus trips and walking trips that are more frequent in urbanized areas.

Similarly, another study showed that people living in mixed and dense urban structures are more likely to walk for short trips than those living in sprawling urban structures (Saelens and Handy, 2008). Cervero (2002) pointed out that the travel context of the urban area where the workplace is located influences the choice of travel mode. The results showed that people

who have their place of work in a high-density area where different modes of transport converge, encourage the use of public transport over the car.

In terms of accessibility, a study from Hunecke et al. (2007) found that a significant impact on reducing the percentage of trips made by private motorized modes can be achieved by introducing a public transport season ticket. These findings are also supported by other studies that brought evidence that availability of a bus season ticket increases students' bus trips (Bamberg & Schmidt, 2003; Kuhnimhof et al. 2012; Zhou, 2012) while reducing car use. Finally, as suggested by Hoffmann et al. (2017), situational conditions may be further imposed by family responsibilities (i.e., children or elderly care). For example, some studies found that the presence of children in the household increases the likelihood to use the car (Kim & Ulfarsson, 2008; Whalen et al., 2013).

Building on the findings collected so far, mobility choices reflect users' beliefs and perception, attitudes towards different means of transport, habits, subjective and objective constraints. Therefore, the scientific literature adopts the term "travel behaviour" (Ben-Akiva et al., 2002), a definition encompassing both knowledge on traffic, built environment characteristics as well as social and psychological aspects concerning decision theory. However, as mentioned at the beginning and particularly when it comes to research in the field of transport economics, the value of time (VOT) (i.e., an economic aspect of travel behaviour) has received central attention because it constitutes a measure to justify investment in transport schemes, both as a reliable driver for investments in infrastructure for car traffic as well as to incentivize the use of sustainable transport modes.

1.1.5 Mode choices and Value of Time

In scientific literature, mobility survey is a topic extensively dealt with, starting from the original definition of time allocation among people's daily routine (see Becker, 2013) to the elaboration of survey and mathematical models to estimate the main and latent variables underlying the topic and their variation over time and over space (i.e., on varying country or region). One of the first concept that it is worth mentioning when dealing with commuters' travel behaviour is the concept of utility (and of its opposite, disutility) associated to the displacement. As the displacement has a utility only when linked to the activity purpose carried out at destination, the travel time is usually perceived negatively, even as lost time especially when distance and personal income increase (Wardman, 2004; Daly and Carrasco, 2009; Borjesson & Eliasson, 2012; Small, 2012).

Within this theme is embedded the concept of Value of Time (VOT). A glimpse of bibliographic review on VOT models is present in Athira, Muneera, Krishnamurthy, & Ankaneyulu, (2016). Scientific literature refers equally to either VOT or Value of Travel Time (VTT; McFadden, 1981), while other monetary evaluations concerning transport behaviour refer to Value of Travel Time Saving (VTTS), Value of Substitution (VOS) and Value of Reliability (VOR). The VOT is a theoretical and quantitative construct widely used in transportation analysis and project assessment in order to obtain a monetary estimation of potential benefits to the community (i.e., travel time reduction). Particularly relevant for commuters, time is a crucial dimension in comparing and selecting the most efficient modes of transport. Based on this assumption, if we ask people to associate a cost to their time spent travelling, including all the efforts and energy spent on the journey, we would have the possibility of assigning a monetary value to the travel time. Thus, VOT is the amount of money that a user is willing to pay in exchange for an hour of reduced travel time. In this scenario, the VOT has assumed significant importance in the planning and management of the transport

system, since it represents the subjective intention to adopt a specific mode of transport. It is considered a relevant indicator in cost-benefit analysis of infrastructure project evaluations and traffic management models (Shires & de Jong, 2009). In other words, the VOT can be used to define pricing policies in both public and private transport and to decide in which type of infrastructure/area to intervene (Zamparini & Reggiani, 2007).

After Becker's definition of the value of a single time, Train and McFadden elaborated a model which was focused on the value of time in the transportation sector (1978). With the proliferation of behavioural theories in the '80s, studies on VOT become more and more consistent. A meta-analysis of studies focused on VOT up to 1995, for example, showed that the average VOT was around $80 (Zamparini & Reggiani, 2007). The same estimation has been made for commuters, which drops to $55, with further variations depending on the type of transport chosen: $56 reported by bus users, $77 by people using the train, $82 for motorists and $145 for people using the plane. Only starting from 2000, the idea that travel time could be associated with an absolute value or even be considered an entertaining activity became popular among the scientific community (Mokhtarian & Salomon, 2001; Jain & Lyons, 2008), in particular if considered the advent of IT as a leading factor enabling users to perform useful activities while travelling, such as social or work activities (on varying travel conditions). The subjective appraisal of time is not only determined by clock time (i.e., actual objective time) but is also influenced by information processing and the events that people experience. To this scope, Galetzka and colleagues (2018) summarized prior studies showing how background music, auditive and visual stimuli, digital information (weather report or news other than delay information) impact processing of time and duration estimates, which in turn influenced passengers' satisfaction greatly. The benefit has been assessed based on standard variables of transportation analysis such as income, age, trip purpose and, more recently, gender. Findings showed higher reduction of VOT for business/commuting travellers (Banerjee & Kanafani;

2008). Moreover, activities performed onboard thanks to IT are roughly irrespective of income and gender (Etminani-Ghasrodashti, Paydar, & Hamidi, 2018; Varghese & Jana, 2018). Finally, millennials have 10-15% lower VOT than other people as well as the higher willingness to pay in change of stable and free wi-fi connection onboard (Malokin, Circella, & Mohktarian, 2017).

As Small (2012) pointed out, research has revealed connections with many factors but also a plethora of reasons for heterogeneity in VOT rooted in behaviour at a micro-scale. For example, VOT variation by time of day is closely connected to trip scheduling and reliability. Travellers' VOT changes asymmetrically around a reference point but, since travel time is not perceived as a single entity, there are several subsets as varying the modal choice varies. Also, the mutual weight – namely the elasticity - is of relative importance (Börjesson, Fosgerau, & Algers, 2016). For example, as far as individual mobility is concerned, in-vehicle time (which is subsequently split into time spent driving in uncongested conditions and congested conditions) and time spent while looking for a parking slot are distinguished. Small (2012) reports that VOT for drivers in the congested condition is up to 30% higher than in uncongested conditions due to accident risk and accident-avoidance effort. As far as public transport is concerned, total time is split between onboard, access/exit, waiting time and transfer time. Usually, elasticity measures take travel time as a reference, while the perception compared to the other subsets described above is worse. For example, the transfer time counts about twice as much in negative as the actual travel time. In addition, other influencing variables are the comfort onboard, reliability (i.e., adherence to the schedule or departing earlier/later) cleanliness, and onboard services (Meunier & Quinet, 2015).

Recently, the VOT concept has also been applied to the potential introduction of autonomous vehicles in everyday traffic. Steck and colleagues (2018) have analysed how the introduction of autonomous driving can somehow change the modal choices of commuters. In

the study, the authors presented two different scenarios, the first in which the autonomous vehicle is privately owned (with the possibility to switch from autonomous to manual driving) while in the second use case the autonomous vehicle is shared with other passengers (shared autonomous vehicles). Results showed that, regardless of the scenario, the introduction of autonomous car could lead to a reduction in the VOT between commuters. In detail, while shared autonomous driving would reduce the VOT by 10%, the chance to own a private autonomous vehicle would reduce the VOT by 31%. The study, as intriguing and forward-looking as it is, underlines the importance of travel time and the way it is allocated. As can be easily inferred, during self-driving, commuters can spend their time working or in positive activities that would reduce their VOT. For example, the VOT of business travellers and commuters is higher in congested traffic than in flowing traffic (Rizzi, Limonado & Steimetz, 2012; Shires & De Jong, 2009). Moreover, studies focused on VOTs comparisons between leisure and shopping trips for commuter estimated higher values for commuting trips (Abrantes & Wardman, 2011). However, considering the commuters' category, the results are inconsistent. While in some studies the VOT of commuters moving by car is higher than in public transport, in other studies the estimates are lower compared to rail transport users (Shires & De Jong, 2009; Abrantes & Wardman, 2011).

The literature about the VOT (or VTTS, VOS, VOR), although extensive, is indeed characterized by substantial heterogeneity in the results (Li, Hensher & Rose, 2010; Shires & De Jong, 2009; Zamparini & Reggiani, 2007). The debate is still very open with researchers arguing against the different methodologies adopted, while others focus on the type of variables used to group the distribution of VOT. Regarding the latter point, the studies have mainly focused on using variables such as salary, the reason for travel, GDP, region, mode, trip length. However, psychosocial variables that have proved to be highly predictive in the field of mobility research, such as PBC, have hardly been considered. In this respect, it is interesting

to mention the study carried out by Abou-Zeid and colleagues (2011) who have demonstrated the influence of personal attitudes towards travel as one of the factors which can explain the variance in the VOT, along with demographic and travel characteristics. Precisely for this reason, in this dissertation, one of the studies presented below considers this gap.

1.2 The research question and the outline of the four studies

The dissertation comprises four psychosocial studies. The work presented here is part of an open and voluntary collaboration with the University Mobility Manager. With the introduction of the ministerial decree entitled "Sustainable mobility in urban areas" (Ministero dell'Ambiente, 1998), the mobility manager was introduced as a professional figure, distinguished in company and area mobility managers. The company mobility manager is responsible for optimizing the movements of workers, intending to reduce the use of the private car. The strategic tool to achieve these objectives is the home-work travel plan (in Italian, "*Piano degli Spostamenti Casa-Lavoro*", PSCL). Some of the possible measures contained in it concern the promotion of (1) collective transport systems (e.g., providing information about the public transport service, low-cost subscriptions, etc.), (2) cycle/pedestrian facilities (e.g., improving lighting and sidewalks, offering discounts for the purchase of bicycles, etc.) or (3) alternative systems with a reduced environmental impact (e.g., car-sharing, car-pooling). Institutes might play a vital role in this regard by being in a position from it is possible to develop policies and implement measures that encourage the academic community to reach their workplaces through sustainable modes of transport, thus preventing and reducing polluting emissions. In this respect, for example, literature has shown that there is an inverse association between workers' perceptions of the role played by their organisation in encouraging people to go to work on foot or by bicycle and the actual use of the private car (Wen, Kite, & Rissel., 2010). Paying attention to the topic by developing a sustainability-

oriented organisational culture, as underlined by the authors, seems to be a crucial step to promote a shift in workers' mobility behaviour.

Few studies have investigated the effectiveness of organisational interventions to promote behavioural change in terms of mobility (Bamberg & Schmidt, 2001; Caufield & Leahy, 2011; Dubuy et al., 2013; Mutrie et al., 2002; Nakayama & Takayama, 2005; Page & Nilsson, 2016; Shoup, 1997). However, there is a need to extend knowledge in this area as each PSCL should be tailored to the organisational context and urban area of reference. As highlighted by Petrunoff, Rissel, Wen and Martin (2015), academic literature is still lacking. The present dissertation is structured around four studies, each of these answering specific research questions aimed at filling identified gaps in the scientific literature and, at the same time, supporting the drafting of the PLSC. Using multiple methods and approaches, the first and the second study explored the moderating effect of distance to cover, thus defining commuter groups. The third study adopted a qualitative approach to investigated constraints, barriers or triggers in the decision-making process of modal choice, whereas the fourth study investigated the value of time (VOT) from a psychosocial perspective.

1.2.1 First study - Mobility behaviours, car use and commuting distances

Previous studies have focused on the combined impact of psychological factors, situational influences, built environment characteristics and mobility constraints on mobility behaviours. However, no studies have yet focused on exploring how the impact of these predictors change because of different distances to travel among university commuters. Some studies focused on the role of different types of variables considering the distance to cover as a direct variable. However, academic research has focused mainly on the study of the determinants of travel behaviour within short-distances (Limtanakool, Dijst, & Schwanen, 2006).

With regards to distance, literature agrees on the absence of a standard definition of distance thresholds (Limtanakool et al., 2006) due to cultural, economic, topographic, and climatic reasons (Scheiner, 2010). Accordingly, the focus was to concentrate the analysis of the present study on three distance thresholds defined to highlight routes within the urban centre (less than 5km), routes mainly from the outskirts to the urban centres (within 30km) and long routes, from one district to another (more than 30km). Therefore, the present study aimed to fill the gap by investigating how commuting distance moderates the combined influence of the psychological, situational, and environmental variables on mobility behaviours. Indeed, the study allowed to highlight which predictors differ in influencing the modal choice by the distance to be covered and which, instead, influence the modal choice regardless of the distance.

1.2.2 Second study - Identifying groups of travellers

The objective of the second study was to identify groups of travellers based on travel behaviour characteristics, thus comparing main environmental, situational, psychological, attitudinal, habitual or motivational factors at similar distances. Indeed, a fascinating line of research has approached the transport behaviour research field by categorizing the population of users in order to identify some peculiar characteristics on which to base interventions and develop persuasive actions (Anable, 2005; De Vos, 2018; Susilo and Cats, 2014; Ye and Titheridge, 2017). These studies have grouped travellers using different approaches and under different behavioural, socio-economic, demographic, psychosocial and motivational variables. In the last years, researchers proposed the investigation of underlying motivations, personality, attitudes, perceptions, travel experiences and travel satisfaction to shed lights on their predicting influence on travel behaviour (Pronello & Camusso., 2011). However, as Anable also stated in her famous article (2005), “the same behaviour can take place for different reasons and that the same attitudes can lead to different behaviours”. Following this line of

reasoning, the present study has grouped commuters starting from their habitual travel behaviour in order to highlight the attitudinal, motivational and situational factors that can facilitate (or hinder) a behavioural change.

Afterwards, considering the membership to the groups of travellers as a dependent variable, the commuters' modal choice has been further investigated adopting a decision tree analysis approach. This approach can provide a comprehensive view of commuters' choice factors and preferences. The overall objective of the study, therefore, was to explore the commuter decision-making predictors at different distance to the final destination. In other words, it has been possible to highlight which factors (environmental, situational, psychological, attitudinal, habitual or motivational) affect individual travel behaviour decision-making process. Transport authorities (e.g., University Mobility Manager) can use these results to further accelerate the integration of active transport modes into the typical multimodal commuter trip chain, as well as to adapt policies to the organisational context and the urban area of interest.

1.2.3 Third study - Perceived barriers to sustainable mobility: a qualitative approach

The success of initiatives in reducing personal car use through behavioural change will mostly rely on the ability to persuade the community to use public or active modes of transport, especially for commuting (Van Acker et al., 2016). Within this framework, a line of research has been focused on exploring attitudes, perceptions and motivations of travel behaviour from a qualitative perspective. This approach has the potential to highlight and deepen the understanding of the triggers and barriers that characterize the decision-making process of travellers when it comes to modal choices. The present study used a qualitative approach with the aim to identify major human, organizational and built environment factors influencing commuters mode choice, with the aim of shedding light on the barriers and factors influencing the shifting towards or the adoption of alternative modes of transport to the car as well as

secondary factors that may lead to the adoption of active and sustainable modes of transport. Understanding perceptions and motivations underlying the modal choice of an academic community may help in reducing the use of private cars and promoting a modal shift with the chance to develop tailored organizational interventions towards sustainable mobility.

This study is based on the previous work (study 2) in which the ad hoc questionnaire created included an open question at the end: "You can use the space below to comment on the questionnaire or the mobility theme of the University". The area dedicated to participants' comments allowed to collect attitudes, opinions, motivations, perceptions or concerns of the academic community on sustainable mobility issues in general or on the reasons for adopting a specific travel chain strategy.

1.2.4 Fourth study - How attitudes, perceived level of service and mode choice shape the value of time

The fourth study aimed at exploring psychosocial predictors of the VOT. The VOT is a theoretical and quantitative construct widely used in transportation analysis and project assessment in order to obtain a monetary estimation of potential benefits to the community (i.e., travel time reduction). Particularly relevant for commuters, time is a critical dimension in comparing and selecting the most efficient modes of transport. Indeed, VOT is considered a relevant indicator in cost-benefit analysis of infrastructure project evaluations and traffic management models (Shires & De Jong., 2009) as well as to define pricing policies in both public and private transport and to decide in which type of infrastructure to intervene (Zamparini & Reggiani, 2007). In other words, exploring the distribution of the VOT among commuters within the company can provide useful guidance to transport managers when it comes to new policies or measures to be implemented in their organisational context.

However, the literature on VOT, although extensive, is characterized by substantial heterogeneity in results (Li et al., 2010; Shires & De Jong, 2009; Zamparini & Reggiani, 2007),

especially when considering the category of commuters. As already mentioned, while in some studies the VOT of commuters travelling by car is higher than that of public transport, in other studies the estimates are lower (Abrantes et al., 2011). One of the reasons identified concerns the type of variables used to group the VOT distribution. In general, the studies have mainly focused on hard variables such as salary, the reason for travel, GDP, region, mode, duration of travel, while psychosocial variables that have proven to be highly predictive in the field of mobility research, such as the PBC, have not been taken into account. The present study sought to fill this gap by investigating how attitudes, perceived level of service and choice of mode of transport determine the value of time.

Chapter 2. Mobility behaviours, car use and commuting distances

2.1 Introduction

The present study focuses on car use among students, administrative and academic staff from an Italian academic organization. The rate of motorization in Italian cities is one of the highest in Europe (603 cars / 1000 inhabitants; Istat, 2015). More recently, Eurostat (2016) has shown that while the EU has 505 cars per 1,000 inhabitants, in 2016 the density of cars in Italy peaked at 625 cars per 1,000, second only to Luxembourg (662). According to a recent audit on passenger transport data in the EU, 80.1% of the trips were made by car in 2014, thus depicting Italy as an "automobile-oriented culture" (European Commission, 2016).

Furthermore, previous study explored car use determinants within an Italian academic institution since universities significantly contribute to the traffic (Khattak et al., 2011), also because they often represent a critical actor in the cities where they reside for the number of employees/students involved. Any of their efforts towards sustainability would help to establish examples for society in general (Zhou, 2012). Then, it can be hypothesised that even the slightest change in terms of mobility behaviour can have a significant impact on the overall mobility patterns. This aspect is of greater importance if it is considered the Multi-campus structured of the University of Bologna. To improve the functionality and quality of life of the university community, through the years, the University has established five campuses in the central provinces of the Region (Bologna, Forlì, Cesena, Ravenna and Rimini), where distances of up to 300 km are included. These urban cities, where the academic population is an essential part of the population of that urban area, are well connected by highways and railways as well as by regular buses.

Previous studies have focused on the role of different types of variables considering the distance to cover as a direct variable. Indeed, commuting distances have been found to affect car use, the long distance to be covered, the higher the tendency to use the car (Lind et al.,

2015; Loukopoulos & Gärling, 2005; Zhou, 2012). Although a few studies have explored modal choices controlling for the distance to the final destination (Shannon et al., 2006; Whalen et al., 2013), these studies focused their analysis only within a limited range of distance (i.e., 10km). The current academic institution has a multi-campus structure within different cities in the region of Emilia-Romagna, where distances to reach the campus could reach up to 300 km. Therefore, it is essential to examine every little change of car use considering the distance to the campus, in order to explore the individual-specific explanatory variables (Whalen et al., 2013), and to develop appropriate policies and interventions. With regards to distance, literature agrees on the absence of a standard definition of distance thresholds (Limtanakool, Dijst, & Schwanen, 2006) due to cultural, economic, topographic, and climatic reasons (Scheiner, 2010). Accordingly, our focus was to concentrate our analysis on three distance thresholds defined by the direct knowledge of the context: short (<5 km), medium (5-30 km), and long commuting distance (> 30 km). This differentiation made it possible to highlight routes within the urban centre (less than 5km), routes mainly from the outskirts (within 30km) to the urban centres and long routes, from one district to another (more than 30km).

Regarding the sample, we decided to consider the role within the university as a predictor of commuting modal choice for one main reason. Although there is a large amount of research that has focused on how to increase the use of active transport among students, in this study the main target is university commuters, including professors and staff, who have rarely been considered as primary target (Rybarczyk, 2018).

In conclusion, to the authors' knowledge, there are no studies that have considered the commuting distance as a moderator of the combined influence of different variables on the university community modal choice within a broad geographical area of investigation. Therefore, the main research questions of the present study are addressed as follow:

RQ: How do the psychological factors, situational influences, built environment characteristics and mobility constraints considered together influence the choice to use the car to reach the campus among university commuters? Are there any predictors that differ in influencing the modal choice depending on the distances to be covered? Are there predictors who influence the modal choice regardless of the distance to be covered? Do students, professors and staff adopt different commuting strategies depending on the distance to be covered to reach the University?

2.2 Materials and Method

2.2.1 Procedure

Data collection was initiated after approval from the Ethical Committee of the University of Bologna had been obtained. The survey was conducted using a web-based online questionnaire addressed to three different groups within the organizational context: (i) students, (ii) professors, and (iii) university staff. A link to the online questionnaire was also published on the website of the University Mobility Service, where participants could access information about the purposes of the research, data protection, and privacy issue statements. Ninety thousand four hundred eighty-eight students and staff received the link using university emails.

2.2.2 Participants

A total of 4,135 participants from the academic institution filled in the questionnaire. Table 1 shows the frequencies of participants' gender and age for the entire sample as well as for each academic category. Missing values accounted for the 2.5% of the entire sample (n= 103).

Table 1. *Age and gender frequencies and percentages per status category*

	Age		Gender		Total
	M (min; max)	*SD*	Male (%)	Female (%)	Freq. (%)
Students	22.98 (18;68)	3.60	1196 (40.7%)	1745 (59.3%)	3028 (73.2%)
Professors	49.83 (33;74)	9.53	220 (58.5%)	156 (41.5%)	378 (9.1%)
University staff	48.26 (26; 77)	8.25	234 (32.7%)	481 (67.3%)	729 (17.6%)
Total	29.96 (17;77)	12.71	1650 (40.9%)	2382 (59.1%)	4135 (100%)

Based on the latest report on the academic community (UNIBO, 2018), the University of Bologna counts 86509 students (93.8%), of whom 55.4% are women, 2748 professors (3%) of whom 60.5% are men, and 2967 university staff (3.2%), of whom 66.1% are women. According to the descriptive data of the academic population, the current sample cannot be considered representative of the entire academic population, even if there are similarities, regarding the gender distribution among the various academic categories. Based on the descriptive data of the university considered in the study, the students and people working in the university represent about 4,5% of the actual academic population. This aspect provides useful information on the possibility to generalize (or not) the current results.

2.2.3 Measures

Sociodemographic, situational, and built environment variables. The online questionnaire was developed to investigate age, gender, university status (i.e., students, professors, staff), place of departure (i.e., population density, that is, based on the place of departure, number of inhabitants per square kilometre; ISTAT, 2018), commuting distance (short/medium/long), bus season ticket (yes/no), train season ticket (yes/no), experience with any kind of relocation or residential change during the past 5 years (any/once/twice/more than twice), availability of shared mobility services nearby home (yes/no), and the necessity to make stops during the commuting trip due to any kind of family reasons (e.g., children, elderly care or people with disabilities).

Habitual car use and bike use (Chen & Chao, 2011). Present car use was measured with a single item "Regardless of the season and the place you live in, how often do you usually use the car?". This dimension would be considered as an indirect habitual use of the car as a mode of transport, irrespective of the context and the nature of the trip (i.e., recreational or commuting trip). The item was a 5-point rating scale ranging from 1 = never to 5 = almost every day. The same kind of item was used to measure habitual bike use.

Perceived behaviour control (Klöckner, & Blöbaum, 2010, Cronbach's alpha = .81). The scale explores the degree to which perceived behavioural control and subjective constraints affect the mode choice in favour of car use with two items (e.g., "It would be difficult to manage my frequent trips with environmentally friendly means of transportation" and "Circumstances force me to use the car on my frequent trips".). Participants were asked to express their degree of agreement with each statement on a 5-point Likert scale ranging from 1 = completely disagree to 5 = completely agree. The composite score has been reversed to facilitate the interpretation of results.

Personal Values (Klöckner, & Blöbaum, 2010, Cronbach's alpha = .72). Participants were asked to express their degree of agreement about car use reduction and the effects of car use on environmental quality with four items (e.g., "Due to my values, I feel personally obliged to use a sustainable mode of transport instead of the car"). Each statement was evaluated on a 5-point Likert scale ranging from 1 = completely disagree to 5 = completely agree.

Commuter Car Choice ratio (Bamberg et al., 2003). Participants were asked to describe their trip chain to and from the campus. Respondents registered each step of their trip defining the travel mode used and an estimation of time and distance. Instead of registering each daily trip through an online diary, participants were asked to describe the most ordinary commuting trip. From this dimension, we extrapolated the share of car use within the whole daily commuting trip chain.

2.2.4 Statistical analysis

The collected data were analysed using IBM SPSS 25. Before any statistical analysis, data cleaning and missing values analysis were conducted following the Little and Rubin's framework (Schafer & Graham, 2002). The Little's MCAR test was significant ($\chi 2$= 271,488, df = 91, p = ,000) revealing a potential absence of data randomly distributed (MAR). As already suggested from Osborne (2013), since patterns of missing data could be meaningful, we handled the missingness by preforming a Multiple Imputation (MI) for missing values (Garson, 2015). In recent years, this strategy has been receiving more and more attention due to the combination of complex predictive applications of multiple regressions (e.g., maximum likelihood estimation, Markov Chain Monte Carlo simulation) to estimate missing values from the information available in the existing data. As suggested by previous studies, we performed a minimum of 20 iterations (Graham, Olchowski & Gilreath, 2007) and including auxiliary variables (e.g., variables significantly associated with the reasons of missingness) to make the imputation robust even in an MNAR situation.

Since the selected and dependent variable were not normally distributed, we performed a Bayesian regression (Muthén, 2011). Bayesian methods offer theoretical and practical advantages, as compared with the standard frequentist test (e.g., Wagenmakers, Lee, Lodewyckx, & Iverson, 2008). For example, the use of Bayesian methods results in more accurate results than the frequentist test when parameters are not normally distributed (e.g., Lee & Song, 2004). Bayesian analysis estimates the lower and upper values of the credible intervals in which the actual parameter can be found for the observed data within a confidence interval level (Zyphur & Oswald, 2013). Confidence level to estimate the credible intervals were conventionally set to 95%.

Finally, by applying proportional weights to cases, stratified by role and gender (i.e., % of the stratum in the population divided by the % of the stratum in the sample), it has been

possible to inflate under-sampled cases, deflate over-sample cases and eventually reduce sampling error (Maletta, 2007).

2.3 Results

Descriptive statistics of the variables considered in the analysis are shown in Table 2.

Table 2. *Descriptive statistics of selected variables*

Explanatory variables: socio-demographic, situational, environmental and psychological variables				
Socio-demographic				
Age	Mean	*SD*		
	30	12.71		
Gender	Male	Female		
	40.9%	59.1%		
Status	Students	Professors	University staff	
	73.2%	9.1%	17.6%	
Built Environment				
Population density (inhabitants/km^2)	Mean	*SD*		
	1386	1017.65		
Share mobility service availability	Yes	No		
	22.6%	77.4%		
Situational				
	Yes	No		
Bus season ticket	37.1%	62.9%		
Train season ticket	24.8%	75.2%		
Family needs	13.3%	86.7%		
Habit discontinuity	Never	Once	Twice	More than twice
	53.6%	30.8%	9.0%	6.5%
Psychological				
	Mean	*SD*		
Past car use [a]	3.34	1.54		
Past bike use [a]	2.86	1.46		
PBC	3.20	1.33		
Personal Values	3.43	0.76		

[a] Past mobility behaviours have been included in the psychological dimension. They are considered as an indirect measure of the habit of using the means of transport, regardless of the context and nature of the trip (e.g., recreational or commuting trip).

Bayesian regression means and credible intervals are shown in Table 3. We based our analysis on exploring the critical determinants for differences and impact changes of car use depending on the distance to cover to reach the campus, specifically for short (38.2%), medium (29.3%) and long (32.5%) commuting distances. Following the suggestion given by Whalen et al. (2013), the primary purpose was to explore and identify the factors that affect and vary car use choice by comparing distances to campus.

Table 3. *Bayesian regression of car use based on commuting distances*

	Short trip	Medium trip	Long trip
	M (95% *CI*)	*M* (95% *CI*)	*M* (95% *CI*)
Socio-demographic			
Age	-0.00 (-0.00; 0.00)	0.00 (-0.00; 0.00)	0.00 (-0.00; 0.00)
Gender (Male)	-0.00 (-0.02; 0.02)	0.003 (-0.03; 0.04)	0.00 (-0.02; 0.03)
Status			
Students	**-0.12** (-0.18; -0.07)	**-0.18** (-0.27; -0.10)	0.01 (-0.06; 0.08)
Professors	0.03 (-0.01; 0.08)	0.03 (-0.03; 0.09)	0.03 (-0.03; 0.08)
Staff	*REF*	*REF*	*REF*
Built Environment			
Population density	**-0.00** (-0.00; -0.00)	-0.00 (-0.00; 0.00)	0.00 (-0.00; 0.00)
No share mobility services	0.01 (-0.01; 0.03)	**0.07** (0.03; 0.12)	0.02 (-0.00; 0.05)
Situational			
Bus season ticket (Any)	**0.04** (0.01; 0.06)	**0.22** (0.18; 0.25)	**0.24** (0.21; 0.27)
Train season ticket (Any)	-0.01 (-0.08: 0.07)	**0.22** (0.17; 0.27)	**0.27** (0.24; 0.30)
Family needs (Any)	**-0.06** (-0.09; -0.03)	**-0.05** (-0.09; -0.00)	-0.03 (-0.07; 0.01)
Habit discontinuity			
Never	0.02 (-0.02; 0.06)	-0.00 (-0.08; 0.08)	-0.06 (-0.13; 0.02)
Once	-0.00 (-0.04; 0.03)	0.04 (-0.04; 0.12)	-0.05 (-0.12; 0.03)
Twice	-0.01 (-0.05; 0.03)	0.02 (-0.08; 0.13)	**-0.12** (-0.21; -0.03)
More than twice	*REF*	*REF*	*REF*
Psychosocial			
Car use habit	**0.02** (0.01; 0.03)	**0.06** (0.04; 0.07)	**0.01** (0.00; 0.03)
Bike use habit	**-0.01** (-0.01; -0.00)	**-0.02** (-0.04; -0.01)	**-0.01** (-0.02; -0.00)
PBC	**-0.05** (-0.06; -0.04)	**-0.10** (-0.11; -0.08)	**-0.07** (-0.09; -0.06)
Personal Values	**-0.02** (-0.04; -0.01)	**-0.03** (-0.05; -0.00)	-0.00 (-0.02; 0.01)

Note: Confidence level was conventionally set to 95%, Values in **bold** are statistically significant at p< .05
REF: it represents the level of the ordinal/nominal variable selected as reference for the analysis

Regarding the short commuting trip, the variance explained is .27. Results suggest that students are more likely than professors and university staff to a use sustainable mode of transport than the car for a commuting trip within 5 km. Moreover, leaving from a place with higher population density reduces the use of the car. Furthermore, not having a bus season ticket is likely to prompt the use of the car, whereas the lack of family needs leads to a decrease in the likelihood to use the car. Concerning habitual mode use behaviours, being used to driving is likely to facilitate the use of the car for one's commuting trip, whereas being used to cycling is likely to reduce the use of the car for short commuting trip. Finally, personal values are likely to reduce the use of the car for short commuting trips.

Regarding the medium commuting trip, the variance explained is .54. For a commuting trip between 5km and 30km, students are more likely to use a sustainable mode of transport than a car compared to professors and university staff. Moreover, not having a bus season ticket or a train season ticket is likely to prompt the use of the car whereas the presence of any sort of shared mobility service (e.g., car sharing) facilitates a reduction of private car use. Similar to a short commuting trip, the lack of family needs decreases the likelihood to use the car for the medium trip too. Habitual mode use behaviours are likely to affect the use of the car also in medium commuting trip; indeed, being used to driving is likely to facilitate the use of the car for one's own commuting trip, on the contrary, being used to cycling is likely to reduce the use of the car for medium commuting trip. Finally, both personal values in favour of a sustainable mode of transport, as well as a feeling of having other options of transport than the car, are likely to reduce the use of the car for one's own medium commuting trip.

Regarding the long commuting trip, the variance explained is .47. With regards to the long commuting trip (> 30km), not owning a bus season ticket or a train season ticket is likely to substantially impact the choice of transport in favour of the car. Furthermore, considering the habit discontinuity hypothesis, participants who had experienced more than one change of

residence or relocation during the previous five years were more willing to reduce the use of the car for their long commuting trip. Concerning habitual mode use behaviours, being used to driving is likely to facilitate the use of the car. Whereas being used to cycling is likely to reduce the use of the car for long commuting trip. Finally, while the feeling of not being constrained to use other modes of transport than the car is likely to reduce the use of the private motorized vehicle, personal values in favour of a sustainable mode of transport did not show any significant effect on the car choice for the long commuting trip.

2.4 Discussion

The main aim of the present study was to investigate whether the influence of psychological factors, situational influences, built environment characteristics and mobility constraints on car use are moderated by commuting distance. At first glance, it is noteworthy that the effect of some variables is significant regardless of the distances to be covered. Secondly, a very intriguing aspect is the variance explained by the combination of the variables introduced in the analysis. The results clearly show that for short distances, those involving inner-city routes, there should be other factors influencing one's modal choice. For example, as suggested by Zhou (2012), the chosen area of residence could already explain much more variance of the variables included in the study. Alternatively, personal attitudes and perceptions to the different means of travel can have a crucial role in shaping modal choice decision for short distances (De Witte et al., 2013). Future studies should further explore the determinants of one's modal choice when the distances to be covered to reach the workplace are relatively short (<5 km). In more detail, there are several unique and essential findings of the present study.

First, the results provide support for a recent trend concerning the younger generation (Delbosc & Currie 2013; Kuhnimhof et al. 2012), that students are those more willing to use other modes of transport than the car for their commuting trip, in particular, for short and

medium trips. As stated by Prillwitz and Bar (2011), the younger participants can be considered as "green travellers", even though we were unable to explore the reason behind it. A plausible explanation can be related to participants' income, thus suggesting that professors and university staff are more likely to own a private car than students because they generally have a higher income (Chen et al., 2008; Zaho, 2013). Future studies should deepen mobility needs, attitudes and values of millennials. The main aim is to understand better if their choice are dictated by income constraints or delays in adult life transition (Delbosc & Currie, 2014), by shifts in attitudes (Vij, Gorripaty & Walker, 2017), differences in their daily activities or even by changes in the local transport or land-use systems (Delbosc et al., 2019).

Second, similar to previous studies (Kim & Ulfarsson, 2008; Whalen et al., 2013), our results suggest that the presence of children or the responsibility to take care of elderly relatives and people with disabilities influenced people's choice in favour of private car use. However, the effect was significant only for short and medium trips. In other words, when the distance to cover is considerable, people seem forced to organize their daily activities accordingly, regardless of the presence of family needs and they are thus more susceptible to car use. Anable and Gatersleben (2005), when considering work journeys, pointed out that car use is more attractive because of its convenience (e.g., degree of autonomy). Hence, for trips that do not entail covering a large number of km, people with family needs prefer to use the car for its flexibility. These aspects should be further explored in future studies trying to highlight in which way they need to stop along one's route to meet personal needs (i.e., family needs) influences the choice of means of transport and, at the same time, to understand which aspects and characteristics of the various means of transport available best meet these needs.

Third, our results support the notion that regardless of the distance to cover and the university status, people without a public transport season ticket, are more willing to use of the car (Hunecke et al., 2007; Limtanakool et al., 2006). This result is in line with previous findings

which suggest that the availability of a bus ticket increases students' bus trips (Bamberg et al., 2003; Khunimhof et al. 2012; Zhou, 2012). Moreover, it also turned out that the absence of a train season ticket positively impacts car use for all the groups (i.e., students, professors and university staff). Nonetheless, our study supports this notion only for the medium and long train trip, probably because it seems obvious to consider the train as a reliable solution principally for trips that are longer than 5 km. In general, it is stimulating to note that having access to public transport through a season ticket decreases the likelihood of using private cars for one' s commuting journey, regardless of the distance involved. Providing discounted season tickets or any other advantage, seems to be a winning strategy, to be implemented, as demonstrated by previous research, whatever the distance may be.

Fourth, we explored the role of the population density. Even though the effect of this built environment characteristic can appear to be small, we found that people who live in highly populated area are more willing to use an alternative mode of transport instead of the car, which is in line with the previous findings (Chen et al., 2008; Kim & Ulfarsson, 2008; Santos et al., 2013; Zaho, 2013). In other words, living in a highly-populated area can facilitate the use of the sustainable mode of transport if people can easily reach their destination by more relaxing or pleasant mode of transport than by car within a short distance. Policy and interventions should consider the role of built environment influences on modal choice (e.g., street density and sidewalk density) in order to meet the needs of users who prefer not to use the car for their short trip.

Fifth, the presence of a shared mobility service helps people in reducing the use of the car for a medium trip. Having the opportunity to easily access some shared mobility service to cover a limited distance (i.e., from 5 to 30 km) increases the likelihood of using this sustainable mode of transport. At the same time, future studies should investigate the influence of

psychosocial factors that could explain the willingness to share the trip with other (probably unknown) persons for a limited period (i.e., medium trip).

Sixth, in line with previous research, our results support the notion that people who are used to driving in their daily routine, are more willing to use the car in their commuting trips as well, irrespective of the distance to cover. This aspect has been confirmed when controlling for the status category. On the contrary, habitual bike use negatively affecting car use, and people who cycle regularly are more willing to use alternative modes of transport to their car. Probably having experienced the positive effect of such sustainable and active mode of transport (Thomas & Walker, 2015) also affects people's mode choice for commuting trips in a "greener way". Additionally, people who are used to take alternative modes of transport than the car (i.e., bicycle) may be more open to travel options in their commuting trip. In the end, what is worth noting is that a past positive modal experience, changed into an automatic process (i.e., habit), has become an automatic decision-making process that can influence our choice of modal commuting, regardless of the distances to travel. In other words, those who are used to driving a car, it may be challenging to make a modal shift, unless a disruptive event occurs as suggested by the habit discontinuity hypothesis.

Indeed, according to the habit discontinuity hypothesis (Verplanken & Wood, 2006), when the context changes occur, it may disrupt people's habits and a "window of opportunity" might open, giving people the chance to redefine their behaviours by considering other mobility patterns deliberately and intentionally. Interestingly, our results suggest that only people who have experienced more than one disruptive event during the past five years are more likely to reduce the use of the car, only for long commuting trip. Future study should explore which situational characteristic could buffer the resistance in changing one's habits (Yalachkov, Naumer & Plyushteva, 2014).

Finally, PBC and values were significant predictors of car use negatively. People who did not feel constrained in their mode choice and exhibit pro-environmental beliefs were more likely to use other modes of transport than the car. However, for long distances, values and norms did lose their impact on mode choice, probably because the distance has a stronger and contingent influence on people's mode choice than one's values. As suggested by Khunimhof et al. (2012), people prefer maximizing the utility (or minimize the disutility) of travelling instead of prioritizing, for example, the quality of the environment and air pollution.

There are several limitations to our study. First, the response rate of the study was low and, considering the descriptive of the overall academic population (see 2.2), the findings could not be considered representative of this Italian academic organization. However, by applying proportional weights based on the percentage of male and female among academic category, it has been possible to reduce sampling error. Nevertheless, it is preferable to underline that findings cannot be generalised to the whole population. Second, our measures were self-reported and may be subject to reporting bias even though other previous research on the topic has been conducted using an online survey (Shannon et al., 2006). Third, the cross-sectional design precludes from causality or chronological order of changes. Therefore, researchers should try to adopt and implement a longitudinal study design to better understand modal choices over a certain period and be able to uncover and determine the combined casual impact of psychological factors, situational influences, built environment characteristics and mobility constraints on mobility behaviours.

Chapter 3. Identifying groups of travellers

3.1 Introduction

Against all efforts undertaken towards more sustainable mobility, people still mostly rely on the car's performance in matching and meeting their needs when travelling (Buehler, Pucher, Gerike, & Götschi, 2017). Indeed, even if there are more and more examples where car use is starting decreasing, Italy represents one of the countries with the highest motorization rate per person in Europe (i.e., 625 cars per 1,000 inhabitants; Eurostat, 2016), second only to Luxembourg (662). As political and media attitudes towards this issue have grown, several researchers have focused on understanding the main determinants of modal choice in order to promote greater adoption of environmentally sustainable means.

A fascinating line of research has approached this topic by categorizing the population of users in order to identify some peculiar characteristics on which to base interventions and develop persuasive actions (Anable, 2005; De Vos, 2018; Pronello & Camusso, 2011; Susilo & Cats, 2014; Ye & Titheridge, 2017). These studies have grouped travellers under different behavioural, socio-economic, demographic, psychosocial and motivational variables. The main objective remains the development of policies targeted at specific groups of travellers. In recent years, researchers have proposed to investigate the underlying motivations, personality traits, attitudes, perceptions, travel experiences and travel satisfaction to highlight their predictive influence on travel behaviours (Pronello et al., 2011).

One of the first studies that investigated these mechanisms from a sociological perspective concerning modal choice was the work done by Jansen (1999). Six types of users were defined based on their attitudes as well as their concerns about the environment. Moreover, car drivers were divided into passionate car drivers, everyday car drivers and leisure time car drivers. Cyclists and public transport users, instead, were divided into cyclists/public transport users of heart, cyclists/public transport users of convenience and cyclists/public

transport users of necessity. This segmentation made it possible to highlight some attitudinal and motivational characteristics of the type of users. However, as the author stated, focusing on the differences between users, it becomes clear that one strategy cannot exist that can be adapted to the needs of each group. Accordingly, developing strategies to promote behavioural change is a complex issue and difficult to tackle with a strategy that suits all types of users.

Subsequently, Anable (2005) grouped transport users using the main variables of the TPB (Theory of Planned Behaviour, see Chapter 1). Although the sample was composed exclusively of tourists, the study made it possible to distinguish between car owners (i.e., malcontent motorists, complacent car, addicts, die-hard drivers, aspiring environmentalists) and non-car owners (i.e., car-less crusaders, reluctant riders). The exciting aspect of this work was the possibility to distinguish different types of users, each with specific values, attitudes and preferences, such as to suggest the need for ad hoc strategies to facilitate a modal shift. A different approach has been adopted by Diana & Mokhtarian (2009) who grouped transport users through objective measure such as their typical weekly mileage of different modes of transport (i.e., (1) driver or passenger in any personal vehicle, (2) bus, (3) rail and (4) walking, jogging, cycling. Comparisons between levels of use of cars and public transport modes revealed that socioeconomic characteristics alone could not explain travel patterns. Moreover, strong users of a given mode seemed more willing to balance their "modal consumptions".

Lately, an interesting study from Molin and colleagues (Moli, Mokhtarian & Kroesen, 2015), clustered road users based on their self-reported frequency of mode use. The latent class cluster analysis identified (multi)modal travel groups (i.e., the car multimodal users; the bike multimodal group; the bike and car group; the car mostly group and the public transport group) that support authors to explore the effects of socio-demographic variables as well as of perception and attitudinal dimensions towards each mode of transport.

However, as Anable also stated in her admired article (2005), “the same behaviour can take place for different reasons and that the same attitudes can lead to different behaviours”. The same point is supported by Molin and colleagues (2015) who stress the possibility of mutual influence between attitudes and behaviours over time. Following this line of reasoning, this study has adopted a similar approach, reshaping the point of view from which travellers are grouped.

Therefore, the objective of the present study was threefold: first, to identify groups of travellers based on usual behaviour in choosing the means of transport to go to and from work/study; second, to profile the groups based on socio-demographic, environmental, attitudinal, motivational and psychosocial variables as well as personal satisfaction characteristics about the commuting trip; third, to explore the leading predictors of travel mode choice (i.e., groups of travellers) using a classification three methodology.

3.2 Method

3.2.1 Procedure

Ethical approval for the study was obtained from the Ethical Committee of the University of Bologna. The online survey was administered to the academic community who were invited to participate through an email. A link to the online questionnaire was also published on the website of the University Sustainable Mobility website where participants could access information about the purposes of the research, data protection, and privacy issue statements. The link was sent to 90,488 students, professors and staff using university emails.

3.2.2 Participants

A total of 11773 (response rate, 13.0%) participants from the academic institution fulfilled the questionnaire. Data from participants who not responded to most of the scales of interest or did not complete the questionnaire were excluded, leaving a sample of 8093

participants included in the analysis (actual response rate, 8.94%). Of these, 4798 (59.3%) were female, 243 (3.0%) did not report their gender, and most of them were Italians (94.2%). Considering the overall academic community where students accounted for the 93.8% of the total (UNIBO, 2016), as expected, in the present study the sample was composed mostly of students, 76.3% of participants. Most of them were young people who have left their hometown (40.8%) to undertake, continue or conclude their university path. Professors represented the 11.6% of the population, followed by the administrative staff of the University (7.5%) and all those personnel directly involved in different research activities under project contracts (i.e., fixed-term academic collaborators), research grants or scholarships (4.6%). The sample mean age was 27 years old (SD = 11.81), students' mean age was 22 years old (SD= 4.97), whereas the mean age for fixed-term academic collaborators was 30 years (SD = 9.47). Professors and the administrative staff represent the group with the highest average age, respectively 49 (SD= 9.38) and 47 (SD= 8.34) years old. Concerning general travel behavioural aspects, more than the half of the population travelled within the city of Bologna (63.3%) while the others 16% arrived in Bologna from cities outside the province and the region. The remaining participants studied and worked in the other Campus of the University of Bologna (i.e., Cesena, Forlì, Ravenna, Riccione, Rimini).

3.2.3 Measures

Participants filled out a web-based questionnaire with multi-item scales with a Likert-type response format and multiple-choice questions. The questionnaire contained questions on demographic information such as age, gender, academic status (i.e., resident students, non-resident students, professors and fixed-term academic collaborators, and administrative staff), and nationality. In addition, participants were asked to indicate whether they had a car (Y/N), and a bicycle (Y/N) available for their trips to the university and whether they had purchased a public transport pass (Y/N), regardless of the type of public transport (e.g. bus or train). Also,

the questionnaire investigated if participants experienced any kind of relocation or residential change during the last two years (Y/N). Other areas included information about perceived behavioural control in choosing an alternative mode of transport than the car (PBC), personal pro-environmental norm (PN), attitudes towards different modes of transport (i.e., train, bus, car, bicycle), principal reason for choosing the current accommodation (Residence choice), car and bike habitual use (Habit), personal satisfaction with the commuting trip (Perceived satisfaction), and a detailed description of their own commuting trip chain. Regarding the latter, participants were asked to describe their modal strategy in terms of number of modes chosen within the entire trip as well as the trip length and the time trip for each mode used along the trip chain. In other words, respondents registered each step of their trip defining the travel mode used and an estimation of time and distance. Instead of registering each daily trip through an online diary, participants were asked to describe the most ordinary commuting trip. From this dimension, we extrapolated the share of each mode of transport use within the whole daily commuting trip chain (i.e., ratio of means of transport usage).

Perceived behaviour control (PBC). The scale retrieved from Klöckner and Blöbaum (2010) explores the degree to which perceived behavioural control and subjective constraints affect the mode choice in favour of car use with three items. Items were "*It would be difficult to manage my frequent trips with environmentally friendly means of transportation*", "*Circumstances force me to use the car on my frequent trips*", and "*Reducing the use of the car is completely up to me*". Participants were asked to express their degree of agreement with each statement on a 5-point Likert scale ranging from 1 = *completely disagree* to 5 = *completely agree*. Cronbach's alpha was .767. The composite score has been reversed to facilitate the interpretation of results, that is the higher the scale score, the more the participant perceives the use of alternative means to the car as a reliable option.

Personal Norm, (PN). Participants were asked to express their degree of agreement regarding car use reduction and the effects of car use on environmental quality. One item from Klöckner and Blöbaum study (2010) was used: *"When I have to choose which means of transport to take, I always try to use a sustainable mode of transport*"). The statement was evaluated on a 5-point Likert scale ranging from 1 = *completely disagree* to 5 = *completely agree*.

Attitudes towards different means of transport. To measure participants' attitudes towards the different means of transport, participants responded to 32 items, each one evaluating a specific characteristic of the train, the bus, the car and the bicycle. An example of items was "*Considering the train/bus/car/bicycle, how much do you consider this mode of transport as relaxing/reliable/fast"*. Participants were asked to respond using a five-point scale ranging from 1 (not at all) to 5 (very much). For each mode of transport, we performed an exploratory factor analysis separately, to investigate the dimensions of positive attitudes towards each mean of transport, using principal axis factoring followed by quartimin rotation. The analysis indicated a one-factor solution for each mode of transport. Two items (i.e., *"how much do you consider the train/bus/car/bicycle as economic?"* and "*how much do you consider the train/bus/car/bicycle to be at risk of an accident?"*) were dropped because of its low factor loading for each mode of transport solution (factor loading < .400). Cronbach's alpha for attitudes towards the train, the bus, the car and the bicycle were .832, .827, .802, .804, respectively.

Residence Choice. The scale adapted from Zhou (2012) investigates the primary reason for choosing the current home of residence, which has been seen to influence the students' mode choice. In our study, we wanted to extend the knowledge on this topic by also including professors and administrative staff. Participants were asked to select the main reason why they chose their current residence. Response options were the following: the public means of

transport are close or easy to reach on foot; affordable rental; due to the possibility to live in a neighbourhood with services, adequate infrastructure and green areas; due to the presence of friends or classmates in the area or in the house; living with family/partner; due to the closeness to the Campus where they study/work; other reason.

Habit. In the present study, different habit mode use has been used. The habit is a learned behaviour that is automatically activated in the presence of specific environmental stimuli (Verplanken & Aarts, 1999), whereas the strength of the habit consists in its degree of automaticity that characterizes this stimulus-response association. The study was based on two measurement methods prevailing in literature: the Self-Report Habit Index (SRHI; Self-report index of habit; Verplanken & Orbell, 2003) and the Response Frequency Measure (RFM; Frequency measurement of response; Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994). The first consists of a self-report question, composed of 4 items (with a Likert scale ranging from 1=completely disagreeing to 5=completely agreeing) aimed at capturing both the frequency with which the habitual behaviour is exhibited, and the four aspects that characterize automaticity, proposed by Bargh (1994): (1) lack of intentionality; (2) uncontrollability; (3) lack of awareness; (4) efficiency. We investigated both the habitual car use (Cronbach's alpha .909) as well as the bicycle (Cronbach's alpha .951). The RFM measures the automaticity of habit car use by proposing to the participant a series of different destinations to be reached (e.g., dinner out with friends, going to the cinema...) to which to respond as quickly as possible by explaining which mode of transport would be used (i.e., car or other mode of transport), among the list of alternatives proposed.

Trip Satisfaction. In the present study, five items on a 10 point Likert scale were intended to assess participants' satisfaction in terms of overall satisfaction with their usual travel, personal satisfaction with the length of the trip, the cost of the trip, the perceived comfort and the perceived safety along the way through the following question *"In detail, from 1 (=not*

really) to 10 (=fully), how satisfied are you with the following aspects of your home-university trip?". Cronbach's alpha was .844.

3.2.4 Statistical analysis

A two-step cluster analysis was performed using both categorical (i.e., number of modes of transport within the entire trip) and continuous (i.e., trip length and duration, ratio of means of transport usage) variables which were related to the actual routinely travel behaviour of commuters. The aim was to identify groups of travellers based on their habitual modal choice to reach their final destination. Log-likelihood and Schwarz's Bayesian information criterion were used to determine the optimal number of clusters, defining the maximum number of branched per leaf node and tree depth levels, for a total of 4681 nodes possible. The goodness-of-fit analysis ensures that clusters are distinctly heterogeneous among themselves and as homogeneous as possible within them. Values of 0.50 or more reflect a good fit (Sarstedt & Mooi, 2014). For a further interpretation of the cluster solution, χ^2 tests and ANOVAs were performed on additional categorical and continuous variables (i.e., socio-demographic, attitudinal, psychosocial, etc.), respectively, with Bonferroni adjustment (Beasley & Schumacker, 1995). Interpretation of results was based on both statistical significance ($p < 0.05$) and measures of effect size were based on Cramer's V (i.e., 0.10 for small, 0.30 for medium, and 0.50 for large effect size), and $\eta 2$ (i.e., 0.01 for small, 0.06 for medium and 0.14 for large effect size; Cohen, 1988).

Next, a classification tree methodology was adopted to understand the role of the variables considered in this study in affecting commuters decision-making processes and predicting commuters travel behaviours. Indeed, classification tree analysis (also called "Decision trees") is used to generate valuable rules and relationship with the purpose of predicting each outcome, or events (Batra & Agrawal, 2018). The method recursively classifies cases in order to define a hierarchical model of predictors. In the present study, classification

trees help identify similar patterns which can explain commuter's decision-making process and predict travel mode choice. Due to its non-parametric nature and accessible interpretation, this technique has been widely adopted, even in transport research (Akiyama & Okushima, 2004; de Ona, de Ona & López, 2016; Fraboni, Puchades, De Angelis, Pietrantoni, & Prati, 2018; Pitombo, Kawamoto, & Sousa, 2011; Sekhar, & Madhu, 2016). Moreover, the non-parametric algorithm can handle large and complex database as well as missing values by classifying them as a separate category or use it as a target variable in the decision tree model to estimate predicted value and replace the missing ones (Song & Lu, 2015). Simultaneously, large trees might lead to misclassification, which can be handled by applying a pruning criterion which combined precision criteria. Furthermore, the final model is the combination of a validation process where the sample is divided into two subsets, one sample, called the learning sample is used to split the nodes and the second one, the testing sample, is used to validate the model and test the misclassification procedure (de Ona et al., 2016). Based on the root node, which is the target variable (i.e., traveller groups) that represents the sample, the analysis provides a hierarchical tree of best factors which discriminate the sample into offspring nodes. The classification tree ends when other subgroups can no longer be defined, that is other partitions are not significantly associated with the node and no other variable included as predictor can split the sample into subsequent internal nodes. In the present study, the classification tree analysis was based on the CHAID growing method algorithm, which profiles the sample to the desired categorical outcome (Baizyldayeva et al., 2013). Simultaneously, the CHAID algorithm accepts nominal, ordinal, as well as continuous input variables (Song & Lu, 2015). To facilitate classification rules, independent variables related to psychosocial (i.e., PBC, PN, Habit) and attitudinal (i.e., Attitudes towards different modes of transport) variables have been re-coded in a reduced semantic scale (de Ona et al., 2014). The new scale labelled the rated from 1 to 2.5 as "low", from 2.5 to 3.5 as "medium" and from 3.5. to 5 as "high". By

sequentially partitioning, stopping and selecting the optimal growing tree, the segmentation methodology has been adopted to highlight the main predictors of travel modal choice of commuters. Data were analysed using IBM SPSS 26.

3.3 Results

3.3.1 Cluster analysis

The two-step cluster analysis yielded a five-group solution (Table 2). The average Silhouette coefficient was 0.80, indicating an excellent cohesion and separation. The ratio between the largest and smallest cluster was 2.16, indicating balanced cluster sizes.

The first group (n = 2305) constituted 28.5% of the academic community and was characterized by people who mostly rely on the train (84% of the entire trip) to reach their final destination. Respondents in this group tend to adopt a multimodal strategy; 73.6% of participants change the mode of transport three times along the commuting trip. Besides using the train, in some cases, the other stages of the route are often covered by car (7%), by bus (2%) or on foot (1%). People in this group must cover long distances (M= 63.27 km; SD= 31.69), taking approximately 2.5 hours in total to go to their final destination (i.e. university) and return home. This group was labelled “Long-distance commuters”. The second group (n = 2111) constituted 27.3% of academic commuters and is characterized by being multimodal but with a clear preference for the bus (83%) while the rest of the trip is usually covered on foot (14% of the entire trip). People in this group usually travel about 10 km to reach their department of affiliation (M= 9.85 km; SD= 10.78), taking approximately 1 hour in total to commute. This group was labelled “Regular bus users”. The third group (n = 974), which corresponded to 12.0 % of respondents, is characterized by people who usually take the car for commuting. People in this group usually travel about 25 km to reach their department of affiliation (M= 24.75 km; SD= 27.27), taking approximately 1 hour to commute to and from

the University. This segment was classified as “Car dependent”. The fourth group (n = 1091), which corresponded to 13.5 % of respondents, is characterized by people who prefer to cover their short distance to reach the final destination (M= 3.61 km; SD= 4.69) by cycling (85%) or by taking their moto/scooter (14%). The total duration of the trip is usually about half an hour to commute to and from University. This segment was labelled as “Two-wheels urban users”. The final group (n = 1512) constituted 18.7% of the sample and is characterized by people who need to cover a very short distance (M= 1.69 km; SD= 2,30). People in this group prefer to walk to reach their destination, taking approximately half an hour in total to go and return home. This segment was classified as “Pedestrians” since walking represent the only mode adopted to reach the Campus. All comparisons between groups on the segmentation variables were significant at $p < .001$, with large effect sizes (Table 4).

Table 4. *Comparison of groups of travellers based on segmentation variables.*

	Long-distance commuters (28.5%)	Regular bus users (27.3%)	Car-dependent (12.0%)	Two-wheels urban users (13.5%)	Pedestrians (18.7%)	Segment differences
Modal strategy						χ^2_{16}= 8284.20*; V = .50
Unimodal	3.17 [a]	17.23 [b]	43.43 [c]	98.63 [d]	100 [e]	
Bimodal	4.34 [a]	35.14 [b]	56.57 [c]	1.28 [d]	0 [e]	
Trimodal	73.62 [a]	44.28 [b]	0 [c]	0.09 [c]	0 [c]	
More than three modalities	18.87 [a]	3.31 [b]	0 [c]	0 [c]	0 [c]	
Trip length (km)[1]	63.27 [a]	9.84 [b]	24.74 [c]	3.61 [d]	1.68 [d]	$F_{4,2586.01}$= 2586.01*; η^2 = .61
Trip duration (h)[2]	2.68 [a]	1.24 [b]	1.12 [c]	.57 [d]	.55 [d]	$F_{4,3543.96}$ = 3380.39*; η^2 = .63
Ratio of means of transport usage						
On foot	.01 [a]	.14 [b]	.02 [c]	0 [a]	1.00 [d]	$F_{4,8088}$= 37920.09*; η^2 = .95
Bicycle	0 [a]	0 [a]	0 [a]	.85 [b]	0 [a]	$F_{4,8088}$= 9667.24*; η^2 = .83
Moto/Scooter	0 [a]	0 [a]	0 [a]	.14 [b]	0 [a]	$F_{4,8088}$= 288.43*; η^2 = .12
Car	.07 [a]	.01 [b]	.95 [c]	0 [d]	0 [d]	$F_{4,8088}$= 25418.93*; η^2 = .93
Bus	.02 [a]	.82 [b]	0 [c]	0 [c]	0 [c]	$F_{4,8088}$= 26765.66*; η^2 = .93
Train	.84 [a]	0 [b]	0 [b]	0 [b]	0 [b]	$F_{4,8088}$= 48592.69*; η^2 = .96

Note. Values with different superscript letters in the same row are significantly different from each other at $p < 0.05$. * $p \leq 0.001$.
[1] For the length of the trip is to be considered the average one-way distance (in km) to reach the destination is to be considered.
[2] The average travel time (in hours) to and from the university is to be considered for the duration of the trip.

3.3.2 Profiling the segments

Additional variables were added to provide a broader view of the distinctive characteristics of each group of cyclists. In detail, it was sought to understand whether there were significant differences between the groups of travellers in terms of socio-demographic aspects and environmental factors, psychosocial and attitudinal variables, about the general satisfaction with their trip as well as specific aspects of their route (i.e., cost, duration, comfort, safety and the level of service). More specifically, Table 5 showed comparisons results among the five groups of travellers based on gender, academic status and age, socio-demographic variables, and residence choice for environmental factor. Furthermore, comparisons were further explored based on the availability of a car, of a bike and of a PT pass as well as in terms of experience with any kind of relocation or residential change occurred recently concerning situational factor. Additionally, Table 6 displayed differences between groups based on attitudes towards different means of transport, PBC and PN as well as habitual use of the car and the bike for what concern the attitudinal and psychosocial variables respectively.

χ^2 tests and one-way ANOVAs performed on socio-demographic, environmental and situational variables (Table 5) revealed that participants grouped as "Car-dependent" and “Two-wheels urban users” showed a slightly higher quote of male commuters than the other traveller groups. The employment status composition of the five-cluster solution depicts the "Long-distance commuters" group as mostly represented by students who live in their residential home. The "Regular bus users " cluster included mostly students, whereas the "Car-dependent" was rather widespread among academic roles (mostly home students, professors and administrative staff). The "Two-wheels urban users" and the "Pedestrians" groups consisted mainly of students who have moved away from home on purpose. In terms of age, while commuters classified as “Car-dependent” represent the oldest group (i.e., 34 years old), “Pedestrians” showed the lowest average age.

In terms of main reasons who pushed people in choosing their current living accommodation, "Car-dependent" and “Long-distance commuters“ travellers mainly live with their family or partner, while people grouped as “Pedestrians” and “Two-wheels urban users” have chosen their residence because close to the Campus of belonging. Affordable rental is a residence choice reason characterizing “Regular bus users “, “Two-wheels urban users” and the “Pedestrians” groups. Finally, also the desire to live in a well-served neighbourhood with services, infrastructures and green areas is a valid reason for several groups apart for the “Long-distance commuters”.

The groups show significantly different percentages considering the availability of a car, a bicycle and easy access to public transport. In the "Long-distance commuters" and "Car-dependent" groups, a high percentage of people have access to the car. On the contrary, among "Regular bus users", "Two-wheeled urban users" and "Pedestrians" the percentages are reduced to less than 50%. Almost every group is formed by people who have at least one bicycle available for their journey to their place of work/study. “Pedestrians" represent the group with the lowest percentages of both car and bicycle access. The groups of "Long-distance commuters" and "Regular bus users" consist almost entirely of people with a public transport pass. Also, we investigated the potential impact of a disruptive event such a relocation (e.g., for work or study reasons). People included in the “Regular bus users”, “Two-wheels urban users” and “Pedestrians” groups reported significantly more experiences of relocation in the last two years. All comparisons between the groups were significant at $p < .001$, with moderate-to-high effect sizes for all variables expect gender (Table 5).

Table 5. *Comparison of socio-demographic, environmental and situational comparisons among the five travellers' groups.*

	Long-distance commuters (28.5%)	Regular bus users (27.3%)	Car-dependent (12.0%)	Two-wheels urban users (13.5%)	Pedestrians (18.7%)	Segment differences
Gender (%)						$\chi^2_4 = 94.282^*$; $V = .11$
Female	62.4 [a]	64.3 [a]	56.0 [b]	49.6 [c]	66.0 [a]	
Employment Status, (%)						$\chi^2_{16} = 2577.50^*$; $V = .28$
Home students	62.8 [a]	31.5 [b]	42.3 [c]	18.5 [d]	7.7 [e]	
Away students	16.6 [a]	46.1 [b]	10.7 [c]	52.6 [d]	80.7 [e]	
Professors	7.7 [a]	3.7 [b]	18.5 [c]	9.9 [a]	3.9 [b]	
Administrative staff	9.0 [a]	14.6 [b]	22.4 [c]	12.5 [b]	3.8 [d]	
Collaborators	3.9 [a]	4.1 [a]	6.2 [a, b]	6.5 [b]	4.0 [a]	
Age, $M \pm SD$	26.01 [a] ± 11.09	26.62 [a] ± 12.62	33.62 [b] ± 14.39	27.91 [c] ± 11.83	23.62 [d] ± 8.46	$F_{4,\ 2849.98} = 90.854^*$; $\eta^2 = .05$
Residence choice (%)						$\chi^2_{24} = 3650.37^*$; $V = .34$
Closeness to PT	5.6 [a]	13.1 [b]	2.8 [c]	3.8 [a, c]	3.6 [c]	
Rental	5.3 [a]	20.4 [b]	6.1 [a]	24.3 [b, c]	26.1 [c]	
Neighbourhood services	4.8 [a]	15.7 [b]	16.1 [b]	17.4 [b]	14.3 [b]	
Friends nearby	0.9 [a]	3.7 [b]	1.1 [a]	7.4 [c]	4.6 [b]	
Live with family/partner	76.5 [a]	31.1 [b]	58.2 [c]	19.4 [d]	4.7 [e]	
Closeness to the Campus	1.5 [a]	5.6 [b]	6.5 [b]	18.4 [c]	41.5 [d]	
Other	5.5 [a]	10.3 [b]	9.2 [b]	9.4 [b]	5.2 [a]	
Availability						
Car	84.6 [a]	43.3 [b]	96.2 [c]	45.4 [b]	21.3 [d]	$\chi^2_4 = 2302.98^*$; $V = .54$
Bike	80.2 [a]	55.0 [b]	77.6 [a]	94.3 [c]	42.1 [d]	$\chi^2_4 = 1140.62^*$; $V = .38$
PT pass	93.0 [a]	88.1 [b]	18.1 [c]	19.0 [c]	20.4 [c]	$\chi^2_4 = 4140.13^*$; $V = .72$
Habit discontinuity (%)						
Yes, relocation occurred	19.8 [a]	44.9 [b]	18.4 [a]	50.5 [c]	67.8 [d]	$\chi^2_4 = 1144.66^*$; $V = .38$

The five travellers' groups were compared in relevant dimensions examined in previous studies. We investigated group differences in attitudes towards different means of transport (i.e., car, bike, bus and train), their perceived control over travelling the same route by adopting alternative modes than the car (PBC), personal values towards the environment and the need to change one' s behaviour to tackle the climate challenge (PN), their habitual use of the car or bicycle regardless of their purpose (i.e., RFM, SHRI), their personal satisfaction with the overall journey experience and with specific aspects related to modes and infrastructures.

Tests of differences between segments (Table 6) revealed that participants generally showed a favourable attitude towards the car, regardless of the group they belong to. Moreover, attitudes towards cycling, train and bus did not receive high evaluations. Particularly for participants grouped as "Urban users on two wheels" and "Pedestrians", the bicycle seemed to be slightly more appreciated compared to other groups because it looked fast, relaxing and flexible according to personal needs. Public transport gained low scores from all groups, in particular from people grouped as "Car-dependent", "Long-distance commuters" and "Two-wheeled urban users". More interesting, "Car-dependent" users have reported low scores in attitudes towards any means of transport other than the car. The bus is often considered inadequate to ensure flexibility of movement. It is neither considered relaxing nor comfortable. The train has received a low rating because it is perceived as an unreliable mode, which does not preserve the autonomy and flexibility of the person.

In terms of psychosocial dimensions, "Regular bus users", "Two-wheeled urban users" and "Pedestrians" exhibited a stronger and higher perceived control over their behaviour for what concern the use of alternative modes of transport than the car for their habitual commuting route. The overall sample generally agrees to protect the environment and prevent the negative effects of car use, although the "Two-wheels urban users" and "Pedestrians" groups scored significantly higher than other groups of travellers. Travellers' groups were compared

according to the everyday car and bicycle use. Two different indexes were used, the response frequency measure (RFM) for car use and the self-reported habit index (SHRI) for car and bicycle use. While “Two-wheels urban users” and “Pedestrians” look like people who generally use the car the least of the time, “Long-distance commuters” and “Car-dependent” users strongly tend to choose the car for their trips. The everyday use of the bicycle, on the other hand, characterizes the group of “Two-wheels urban users” significantly more than all other groups.

Finally, results from one-way ANOVA revealed several differences in personal satisfaction for the overall commuting experience as well as for specific aspects of the trip. In general, “Pedestrians” and “Two-wheels urban users” are groups significantly more satisfied with their route compared to all the other groups. Nonetheless, the latter reported significant lower level of comfort and perceived safety than the other groups of travellers. The “Long-distance commuters” instead, expressed significant lower level of satisfaction about their route than all other segments, in particular for the duration of their trip, the related costs and the overall perceived comfort.

Table 6. *Comparison of attitudinal, psychosocial and personal satisfaction aspects among the five groups of travellers.*

	Long-distance commuters (28.5%)	Regular bus users (27.3%)	Car-dependent (12.0%)	Two-wheels urban users (13.5%)	Pedestrians (18.7%)	Segment differences
Attitudes towards different modes of transport						
Attitudes to Car	3.56 [a]	3.53 [a, d]	3.79 [b]	3.39 [c]	3.47 [d]	$F_{4,\ 3352.72} = 58.66^{*}$; $\eta^2 = .02$
Attitudes to Bike	2.86 [a]	2.82 [a]	2.68 [b]	3.39 [c]	2.93 [d]	$F_{4,\ 3343.92} = 162.93^{*}$; $\eta^2 = .07$
Attitudes to Bus	2.06 [a]	2.34 [b]	1.93 [c]	2.15 [d]	2.27 [e]	$F_{4,\ 3349.58} = 106.03^{*}$; $\eta^2 = .05$
Attitudes to Train	2.62 [a]	2.81 [b]	2.49 [c]	2.76 [b]	2.78 [b]	$F_{4,\ 3293.58} = 47.77^{*}$; $\eta^2 = .02$
Psychosocial variables						
PBC	2.80 [a]	3.59 [b]	2.10 [c]	3.91 [d]	4.00 [d]	$F_{4,\ 3432.53} = 1048.81^{*}$; $\eta^2 = .31$
PN	3.52 [a]	3.61 [b]	3.00 [c]	3.84 [d]	3.79 [d]	$F_{4,\ 3316.08} = 116.00^{*}$; $\eta^2 = .05$
Car strength (RFM)	3.27 [a]	2.24 [b]	3.50 [c]	1.83 [d]	1.72 [d]	$F_{4,\ 3398.59} = 469.70^{*}$; $\eta^2 = .18$
Car use habit (SRHI)	2.94 [a]	2.42 [b]	3.32 [c]	2.20 [d]	2.32 [b]	$F_{4,\ 3405.75} = 281.13^{*}$; $\eta^2 = .11$
Bicycle use habit (SRHI)	2.60 [a]	2.33 [b, d]	2.44 [b]	3.86 [c]	2.38 [d]	$F_{4,\ 3411.60} = 447.47^{*}$; $\eta^2 = .18$
Personal satisfaction						
General	5.16 [a]	5.93 [b]	6.22 [c]	7.68 [d]	8.82 [e]	$F_{4,\ 3349.14} = 640.95^{*}$; $\eta^2 = .22$
Duration	4.09 [a]	4.89 [b]	5.77 [c]	7.78 [d]	7.80 [d]	$F_{4,\ 3334.49} = 787.96^{*}$; $\eta^2 = .26$
Cost	4.97 [a]	6.05 [b]	5.55 [c]	8.21 [d]	8.45 [d]	$F_{4,\ 3263.99} = 534.85^{*}$; $\eta^2 = .21$
Comfort	4.33 [a]	4.41 [a]	6.73 [b]	5.94 [c]	7.28 [d]	$F_{4,\ 3249.45} = 504.91^{*}$; $\eta^2 = .20$
Safety	6.29 [a]	6.54 [b]	5.92 [c]	5.23 [d]	7.42 [e]	$F_{4,\ 3270.84} = 147.21^{*}$; $\eta^2 = .07$

* $p \leq 0.001$.

3.3.3 Decision tree analysis

The classification tree analysis generated a model with an accuracy rate of 64.5%. For the overall model, 17 variables were included related to socio-demographic characteristics (i.e., age, gender, role), attitudinal and psychosocial variables (i.e., attitudes towards different modes of transport, PBC, PN, car and bicycle use habit), environmental (i.e., residence choice) and situational factors (i.e., relocation occurred, availability of a car and a bike). According to the results of study 1 (see chapter 2), the distance travelled was included as a categorical variable (i.e. less than 5 km, from 5 to 30 km; over 30 km) in the classification tree analysis. In fact, our objective was to explore how travel choices are also processed based on different distances to be covered (i.e., commuting routes within the urban centre; routes mainly from the outskirts to the urban centres; long routes). The perceived satisfaction with the overall trip and specific aspects of it (e.g., comfort) were not included in the classification tree since they have been considered as outcome events in previous study (de Ona et al., 2015; Ettema, Gärling, Eriksson, Friman, Olsson, & Fujii, 2011). The present study, instead, aimed at exploring critical predictors of travel mode choice based on the groups of travellers.

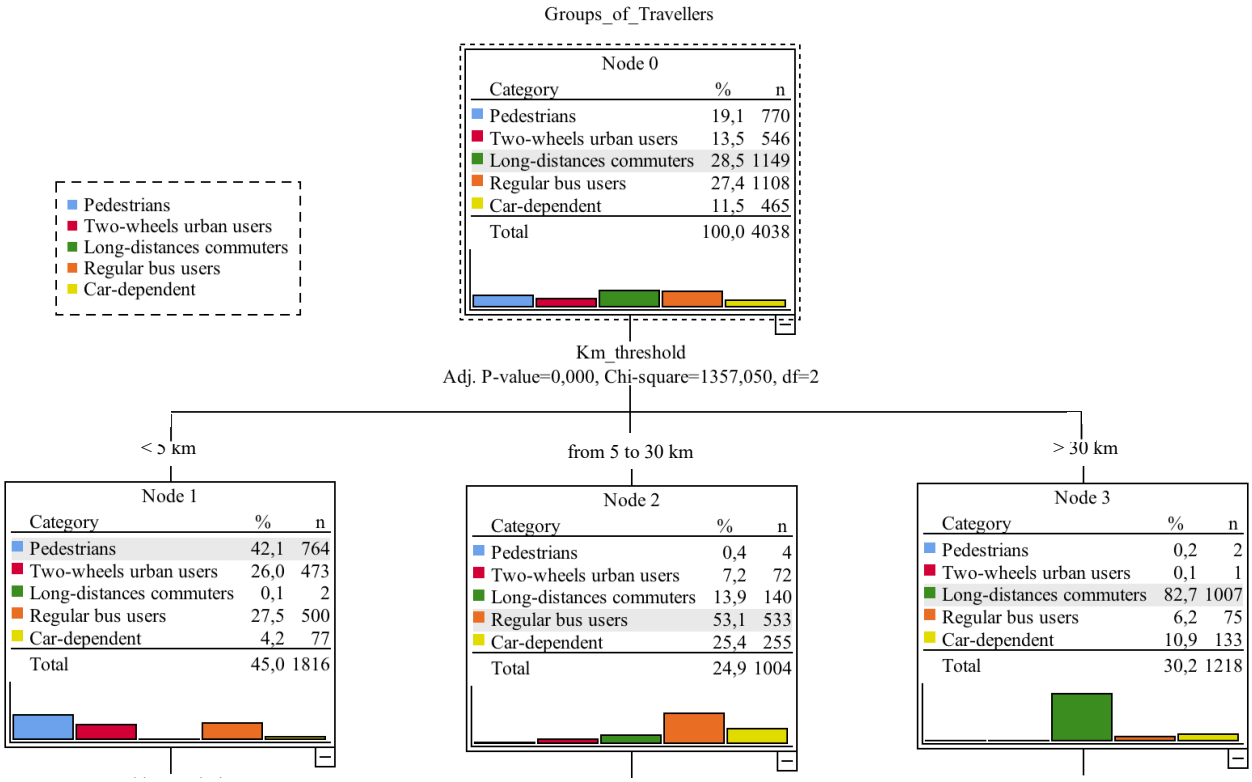

Figure 4. *First partition of the classification tree*

Figure 4 illustrates the classification tree diagram for travel mode choice of commuters, which include 19 terminal nodes. The root node, which is the target variable (i.e., Node 0), is composed by a 19.1% of "Pedestrians", a 13.5% of "Two-wheels urban users", a 28.5% of "Long-distances commuters", a 27.4% of "Regular bus users" and a 11.5% of "Car-dependent" commuters. The first best split is obtain using the variable "trip distance" which has generated three distinct ramifications depending on the distances to be covered, namely short (Node 1), medium (Node 2) and long (Node 3). If the person has to cover short distance, there is a 42.1% to commute by foot, a 26.0% to commute by a two-wheel mean of transport, a 27.5% to commute by bus and a 4.2% to commute by car. Within 5 to 30 km, there is a 7.2% to commute by a two-wheel mean of transport, a 13.9% to commute by train, a 53.1% to commute by bus and a 25.4% to

commute by car. Instead, if the person has to cover long distance, there is a 82.7% to commute by train, a 6.2% to commute by bus, and a 10.9% to commute by car.

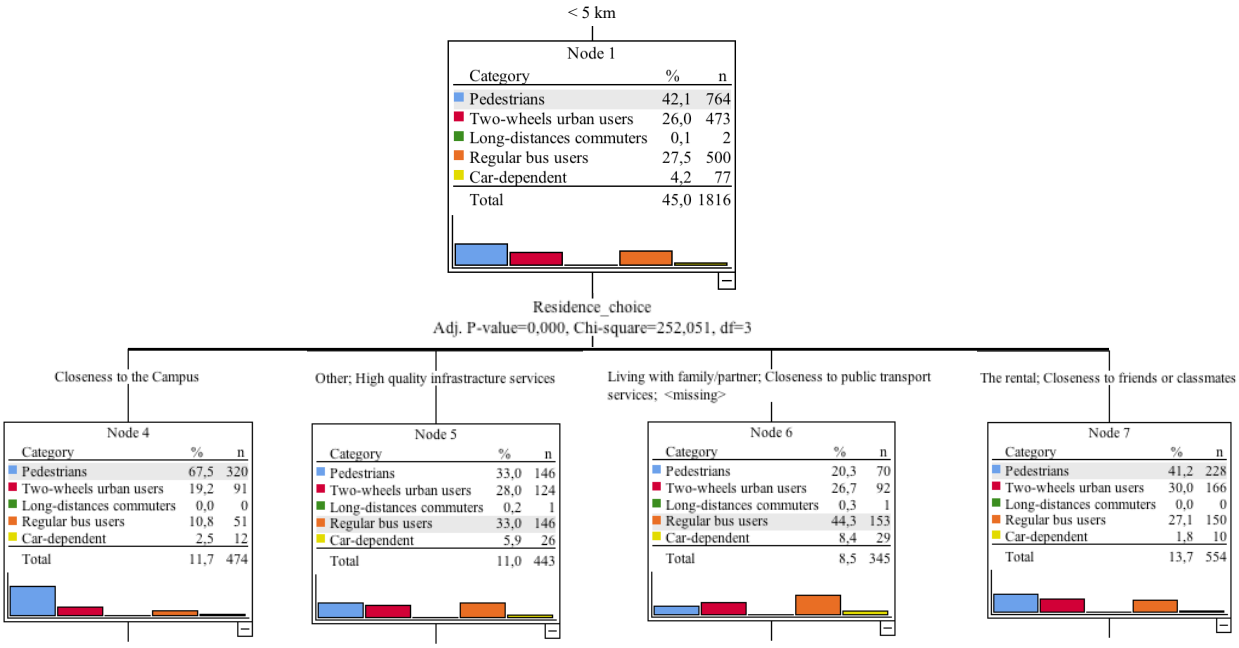

Figure 5. *Classification tree for short distances (< 5km)*

About short distances (<5 km; Figure 5), the classification rules elaborated by the model to predict the travel modal choice are mainly based on the reasons behind the choice of the accommodation. Precisely, if the person chooses the accommodation for its closeness to the Campus (Node 4), a 67.5% would more likely to walk, a 19.2% would cycle, a 10.8% would take the bus and a 2.5% would still drive. If people choose the accommodation to live in neighbourhood with high-quality infrastructure, green areas and good services (Node 5), a 33.0% would more likely to walk, a 28.0% would cycle, a 33.0% would take the bus and a 5.9% would take the car. Otherwise, if people choose the accommodation because public transport stops are close or because it is the dwelling they shares with their family or partner (Node 6), a 20.3% would more likely to walk, a 26.7% would cycle, a 44.3% would take the bus and a 8.5% would take the car to arrive at destination. Finally, if the person chooses the accommodation because close to friends or

classmates (Node 7), a 41.2% would more likely to walk, a 30.0% would cycle, a 27.1% would take the bus and only a 1.8% would rely on the car.

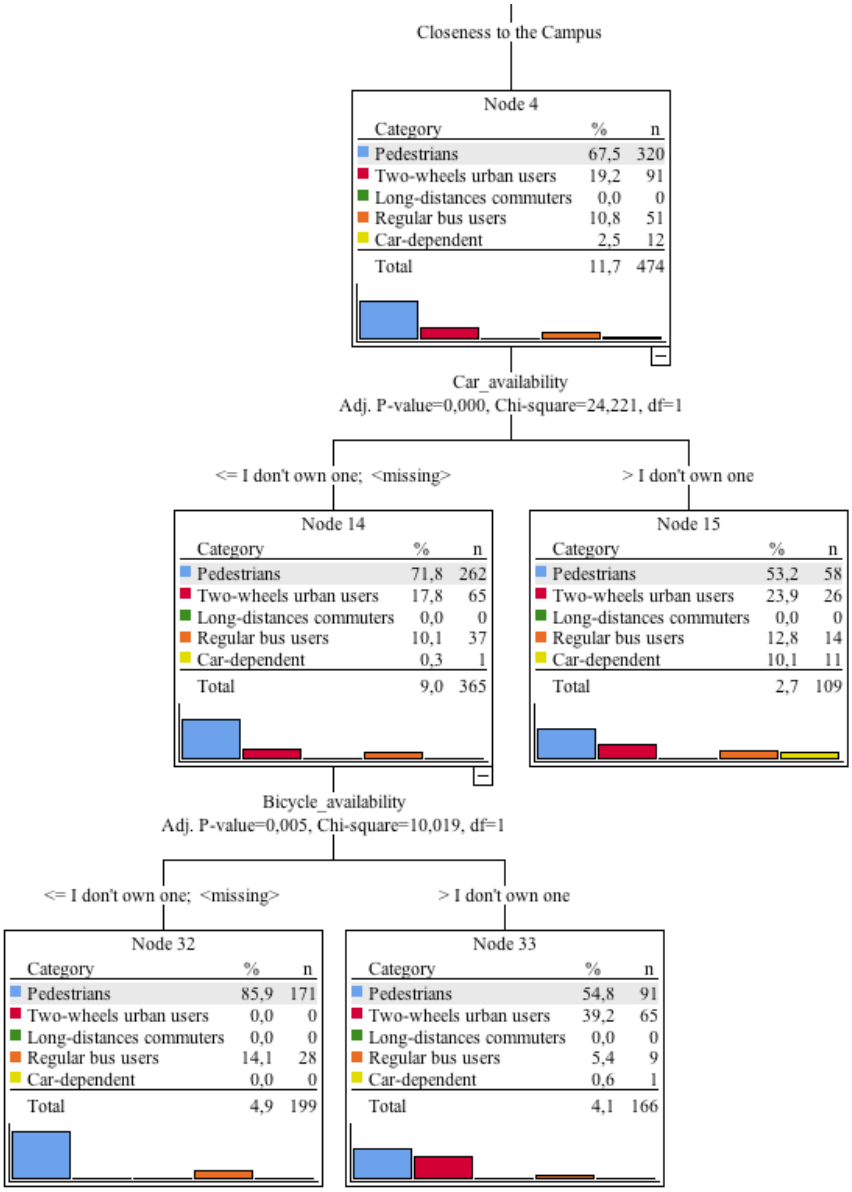

Figure 6. *Classification tree diagram for people close to the Campus*

The travel behaviour decision model made it possible to further explore crucial factors for different residence choice (Figures 6-7-8-9). In detail (Figure 6), if the person live near the Campus, and does not have access neither to a car (Node 14), nor a bike (Node 32), there is an 85.9% of the

possibilities that he/she will choose to walk to reach the destination and a 14.1% of the chance that he/she will take a bus. Otherwise (i.e., access to a bike), the likelihood of cycling increases by 39.2% (Node 33). On the contrary, if the person has access to a car (Node 15), he or she will be still likely to adopt sustainable modes of transport (53.2% walking, 39.2% cycling, 5.4% by bus %), however, that chance of using the car increases by 10%.

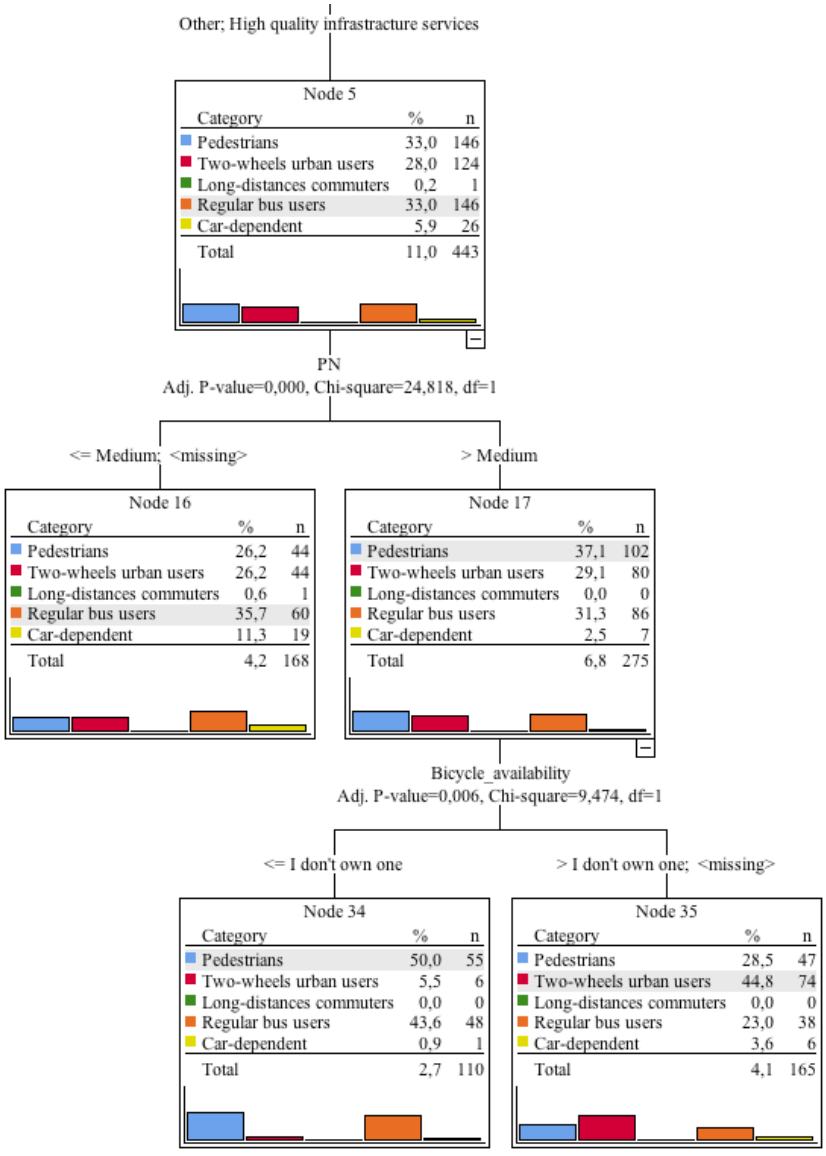

Figure 7. *Classification tree diagram for people living in a neighborhood with high-quality infrastructure*

In the event that the person has chosen the current accommodation because the quality of the infrastructure, the presence of green areas and the level of services are perceived adequate (Figure 7), and does not exhibit a robust moral obligation in using alternative modes of transport to the car (i.e., low level of PN), he/she will still likely to opt for the bus (35.7%) or for an active modal strategy (26.2% walking as well as cycling), however there could be a 11.3% of chances of using the car (Node 16). Commuters who instead embrace pro-environmental value (Node 17) and have access to a bike (Node 35), will be more likely to cycling to the university (44.8%), otherwise, they will be more willing to walk (50.0%) or to take the bus to reach the destination (Node 34).

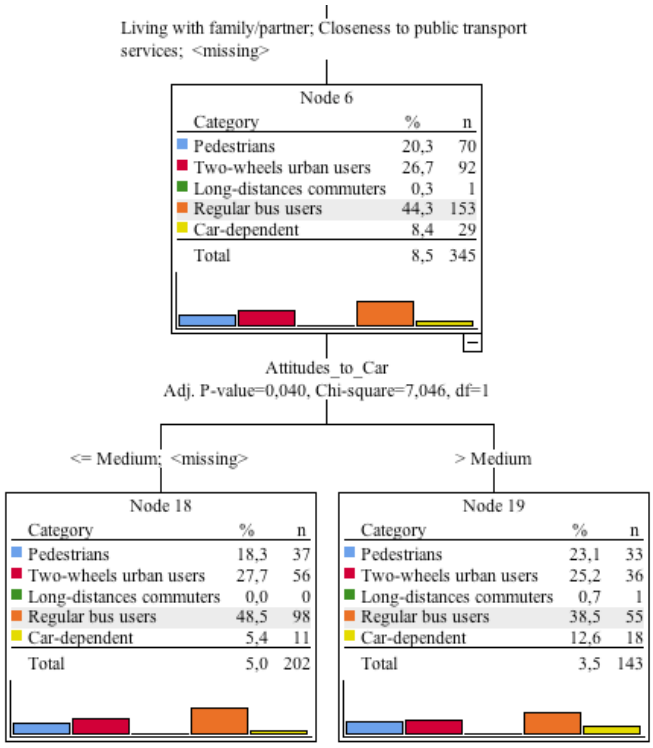

Figure 8. *Classification tree diagram for people living with their family/partner or close to public transport services*

If people choose their home because it is well connected to public transport or because it is the dwelling they shares with their family or partner (Figure 8), and, at the same time, report a

low score in terms of attitude towards the car (Node 18), a 48.5% would take the bus, a 46% would opt for an active modality (27.7% cycling and 18.3% walking) and only a 5.4% will continue to drive. Otherwise (i.e. with a high score in the attitude towards the car), the possibility of using the car increases to 12.6% of the possibilities.

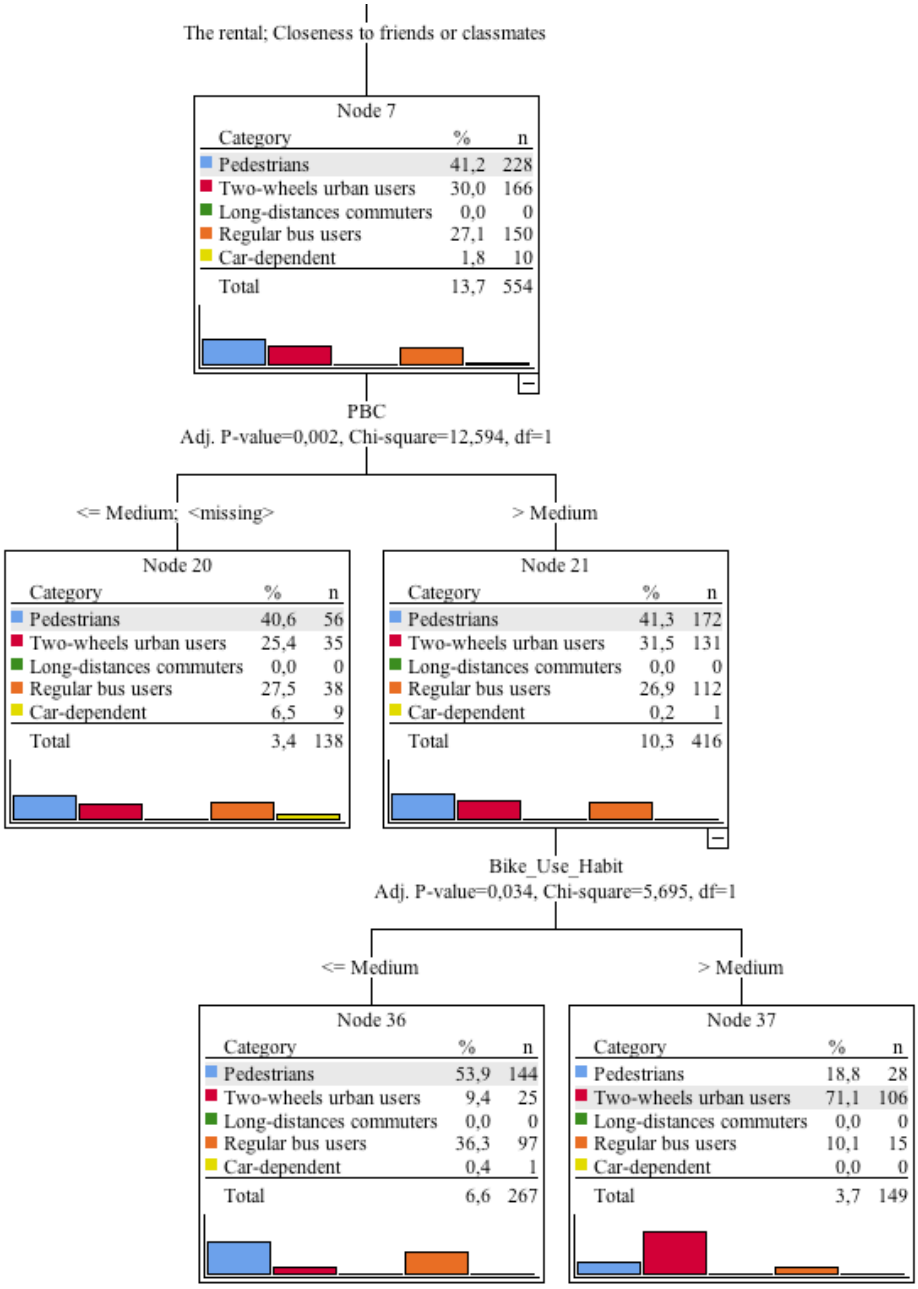

Figure 9. *Classification tree diagram for people close to their friends or classmates*

Finally, commuters who have chosen their home because their friends or classmates are in the same neighbourhood or for an affordable rental and (Figure 9), at the same time, express low levels of PBC, active modes as well as the bus use are still the preferred modes of transport (40.6% by foot, 25.4% by bike, and 27.5% by bus; Node 20). However, the chance of using the car is significantly higher (6.5%; $p < 0.01$) than those with high level of PBC (0% of car users; Node 21). Indeed, if people feel able to commute by other means of transport than the car and are used to cycle, there is a 71.1% of chance that they will take the bike to reach the final destination. Otherwise (Node 36), the person will be more likely to walk (53.9%) or move by bus (36.3%) rather than cycling (9.4%).

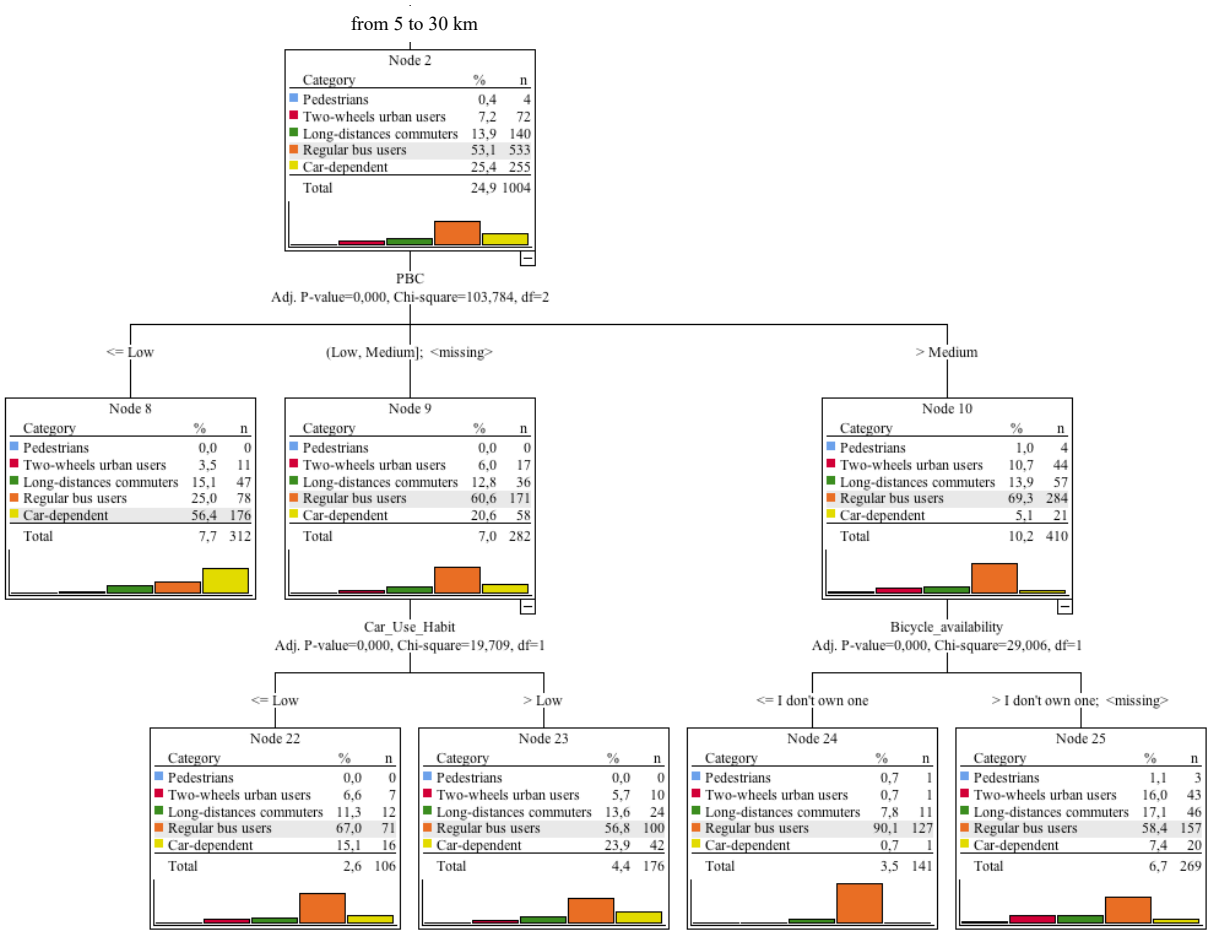

Figure 10. *Classification tree diagram for medium distances (5-30 km)*

About medium distances (from 5 to 30km; Figure 10), the classification rules elaborated by the model to predict the travel modal choice are mainly based on the individual perception of being able to travel with other modes of transport than the car (PBC). In detail, if people report low level of PBC (Node 8), a 56.4% would more likely to drive, a 25.0% would take the bus, a 15.1% would take the train and only 3.5.% would cycling to arrive at destination. On the contrary, the model suggests an inverse relationship between the level of PBC and the likelihood to use the car. In fact, as the perceived control over the modal choice increases, people will tend to rely on the car less (nodes 9 and 10). In detail, those who report neither too low nor too high levels of perceived behavioural control and are not used to drive in general (Node 22), they will tend to commute by bus more (67.0%) while the chance to use the car will be of 15.1%. In case of a strong car use habit (Node 23), the chance of using it will increase up to 23.9% of the cases. Finally, if people exhibit high level of PBC, and at the same time, have access to a bike, the chance of using the car will be reduce to 7.4% of probabilities (Node 25). Otherwise (i.e. not owning a bike), in 90.8% of the cases, people will take the bus (Node 24).

For long distances (> 30 km; Figure 11), the classification rules elaborated by the model to predict commuting travel behaviour are based on the PBC, and commuters' age. As already seen for medium distances, those who exhibit high levels of PBC, are more likely to use alternative means of transport to the car when it comes to cover long distances (Nodes 11-12-13). Specifically, if the person shows very low levels of PBC and is under 24 years old, the chance of take the train is of 83.5% while a 11.6% will opt for the car (Node 26). Otherwise (i.e., people greater than 24), the likelihood of using the car increases to 29% (Node 27). The probability of using the car among those who report neither too low nor high levels of perceived behavioural control, on the other

hand, will be decrease to 5.7% (Node 12), whereas those with high level of PBC, the likelihood to adopt the car as primary mode of transport to reach the university will be of 1.5% (Node 13).

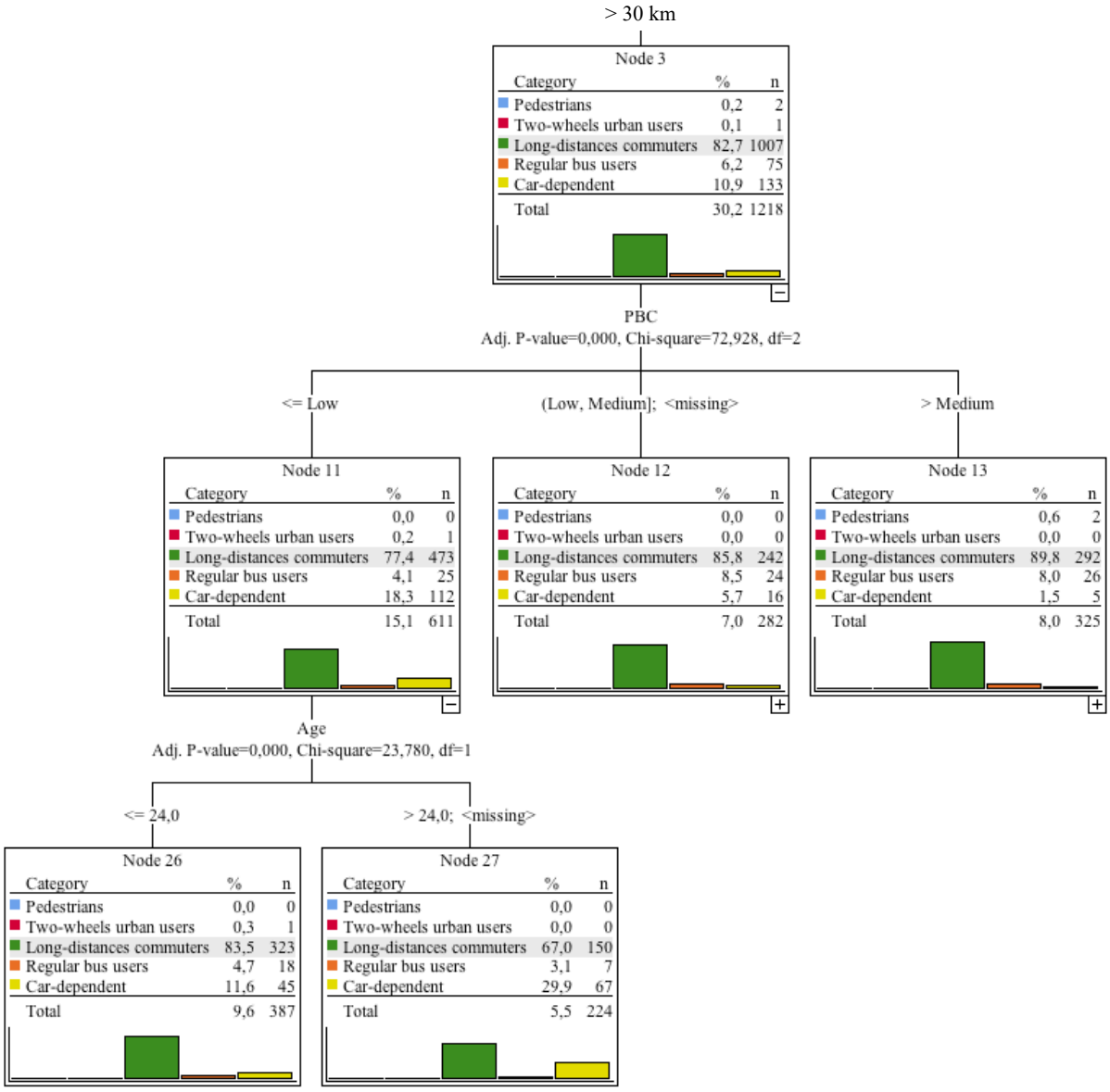

Figure 11. *Classification tree diagram for long distances (>30 km)*

3.4 Discussion

The present study aimed to identify groups of travellers based on their habitual modal choice to reach their place of work/study. Next, by comparing the five groups based on socio-

demographic, environmental, situational as well as attitudinal, psychosocial and trip satisfaction variables, it was sought to provide a broader view of the distinctive characteristics of each group of cyclists. Finally, a classification tree analyses was performed to identify the main predictors of travel mode choice, that is, patterns that can elucidate commuter' decision-making processes in choosing.

Specifically, from cluster analysis, five different types of modal strategy emerged. The first segment labelled "Long-distance commuters", was characterized by people who mostly tend to adopt a multimodal strategy, relying on the train to reach their destination. This group of travellers is mostly represented by resident student who live in their home with their family or partner and did not experience any disruptive event. This group of travellers declared to have access to the car and tend to own a PT pass even though their attitudes towards this mode of transport are more negative compared to the other group of travellers. Indeed, flexibility, comfort and reliability are some of the most critical aspects highlighted by commuters included in this category. The study of attitudes towards PT is well known. In fact, many studies have investigated the impact of attitudes in the travel mode choice, particularly with regard to PT (Bamberg et al., 2007; dell'Olio et al., 2011; Guiver, 2006; Hill et al., 2018; Simsekoglu et al., 2015). Present results suggest that people who use the train to cover long distances are the most dissatisfied. This aspect is particularly interesting, considering what emerged from a recent study from De Vos (2018) where about half of the participants who claimed to use public transport for their trips expressed an evident aversion towards this travel mode. In other words, half of the respondents were not travelling with the preferred travel mode as the group of travellers of the "Long-distance commuters" as well as for those commuters included in the second group, defined as "Regular bus users".

The “Regular bus users” group is characterized by being multimodal. The most widely used trip chain includes bus use and walking, most likely to get from home to the bus stop or to the university once off the coach. People in this group usually travel about 10 km to reach their department of affiliation, are mostly students, with a PT subscription. Despite these aspects, they reported lower attitudes towards PT than all the other segments. As discussed earlier in relation to “Long-distance commuters”, dissonant travellers, as defined by De Vos (2018), seem to confirm what has recently been debated about the relationship between attitudes and behaviour. In the past years, there was a growing idea of a positive relationship between attitudes and the modal behaviour (Beirão & Cabral, 2008; Molin et al., 2016) whereby people with positive attitudes towards a specific mode of transport would be more likely to choose that mode. This seems to be partly confirmed by motorists who show a positive attitude towards the car and might be discouraged to use PT even when it is close to their accommodation.

However, recently results seem to contradict that relationship partly. The discrepancy between attitude and behaviour, also called value-action gap (Blake, 1999), can be explained by several factors such as the perception of control of one's behaviour or specific characteristics of the built environment (De Vos, 2019). For example, being too far from the final destination could force people to adopt means of transport that they do not prefer (Erwing & Cervero, 2010). In the present study, accordingly, people who leave too far from the Campus (i.e., >30km) seems forced to adopt PT even if it is perceived and judged negatively. In addition, depending on how difficult it is perceived to perform a specific behaviour (i.e., PBC on using the PT), the individual will be more inclined to use the car, probably because it satisfies the needs not met by PT (e.g., Bertolini, Curtis, & Renne, 2009). However, although inclined to use the car, the presence of situational and

personal constraints may limit the choice of mode of transport, inducing the use of the TP, thus making the person dissatisfied with the travel behaviour adopted.

The reasons behind the choice of one's accommodation could be another aspect, recently emerged from the literature, that could support the results of the present study (Kamruzzaman, Baker, Washington, & Turrel, 2013). The impact of residential dissonance on mode choice is further deepened by our results which highlight, especially within short distances (<5 km) how the choice of the accommodation influences commuting travel choice. People who choose their dwelling because it is close to the Campus, or well connected to PT or because their friends or classmates are in the same neighbourhood are more willing to use more sustainable modes of transport than the car when their attitudes towards the car are low. However, in the case that a car is available, the probability that this will be used as a mode of transport increases. This result is well supported in the literature regarding the concept of situation influences, in other words, limited access to a car is a crucial factor in fostering the adoption of modes of transport other than the car (Klockner & Blobaum, 2010). Viewed in this way, policies aimed at forbidding the use of the car within short distances (i.e., urban centre route) seems to influence the decision-making process of commuters towards the adoption of sustainable means of transport — a position widely supported in the literature (Bueheler, Pucher, Gerike & Götschi, 2017). Moreover, promoting value-based campaigns towards the environment, thereby stimulating PN, it could encourage people to reduce car use. The strategy seems particularly useful for those who live in a neighbourhood with high-quality infrastructure, green areas and good services.

The third segment is entirely characterized by people who usually take the car for commuting. The “Car dependent” group showed a higher quote of male and older people commuters than the other traveller groups. People in this group declared to have easy access to a

car as well as to a bike. "Car-dependent" users showed the highest scores in terms of attitudes towards the use of the private vehicle. Conversely, they exhibit a substantial habitual use of the car for their movements, regardless of the final destination. Personal overall satisfaction about their commuting trip is moderate and, apart from the comfort experienced by using the car, other aspects such as trip duration, safety and cost ratings are neither particularly negative nor positive. Indeed, the value of time declared by participants belonging to the “Car-dependent” group is the highest among travellers. In general, it is well documented the role played by PBC on car use (Abrahamse et al., 2009; Donald et al., 2014). In the present study, age seems to play a significant role in shaping the decision-making process of commuters. Indeed, as the age increases (i.e., > 24 years), people tend to rely on the use of the car, especially for long distances. This dynamic appears credible when PCB shows low levels. From a certain point of view, these results are remarkable because they can help to deepen the debate about the tendency of the new generation to prefer the use of greener modes (Delbosc & Currie 2013; Kuhnimhof et al. 2012; Prillwitz & Bar, 2011). One of the most discussed points around this topic is whether today's young people have less chance of buying a car than previous generations (Focas & Christidis, 2017). In other words, the decision to adopt the car as their primary mode, nowadays, is only postponed. Others, on the other hand, support the possibility of a new generation that is more inclined to express pro-environmental values and is, therefore, able to get used to moving with sustainable means over time (UK Department of Transport, 2015). From the results of our study, the first position seems to prevail. A lack of PBC could be the result of limited accessibility to the car or a lack of economic resources to buy it. However, as people grow older (and possibly more willing to pay as a result of working actively, getting married or having children), they may tend to rely more on this means

of transport. Future studies on this topic are strongly encouraged in order to prevent the development of a pro-car habit and the continuation of the current problem.

The fourth group is characterized by people who usually cover short-medium distances (less than 10 km) to reach their final destination. People in this group prefer to cycle (85%) or to take their moto/scooter. In the "Two-wheels urban users" group, both male and female are equally represented, whereas students who have relocated for study purposes represent the majority of the commuters in this group. The result on gender distribution appears unusual in light of recent published literature findings, where the use of the bicycle would seem to be predominant among men and young students (Garrard, Handy, Dill, 2012; Wittman, Savan Ledsham, Liu & Lay, 2015). As also pointed out by Prati and colleagues (2019), several explanations have been provided to support these differences such as cycling culture-based factors (Aldred, Woodckc, Goodman, 2016), different attitudes towards cycling infrastructure and environment (Beecham & Wood, 2013) as differences in risk perceptions of cycling (Griffin & Haworth , 2015). The study by Prati et al. (2019) conducted in six-European countries highlighted that among regular cyclists, as two-wheel commuters might be considered, gender differences in attitudes towards cycling tend to disappear. In the present study, bearing in mind that the sample is predominantly composed of women, there is a higher chance that a person will tend to use the bicycle for their home-work/study route when the neighbourhood in which they live has high-quality services and infrastructure. The feeling of living in an area with appropriate features of the built environment (e.g. a cycle path) could reduce the cycling risk perception and facilitate the adoption of this mode of transport.

Furthermore, affordable rental and the opportunity to live near the Campus seemed to be the main reasons for choosing their accommodation within the "Two-wheels urban users" group. These results are supported by previous research which has been focused on the impact of trip

distance and main infrastructure determinants which can facilitate the use of the bicycle (Heinen, van Wee & Maat, 2010). For example, Cervero (1996) found that cyclists commuters tend to live near their place of work. Travellers in this group have shown a high level of overall satisfaction, especially for its duration and cost. A lower level of satisfaction, on the other hand, is expressed in terms of comfort and perceived safety, which remains among the main barriers emerged from previous studies (Gatersleben & Appleton, 2007; Gatersleben & Uzzel, 2007). At the same time, for people used to cycling regularly, with a high level of PBC and living close to their friends or classmates, the likelihood of cycling to university increases considerably. Future studies on this topic are strongly recommended. Regarding future studies, it would be interesting to explore users' characteristics and motivation among people with a high level of PBC who decide to use the bike also for medium distances (i.e., Node 35). In the present study, it was not possible to further investigate the type of bicycle used to cover these distances (e.g., electric bike).

Finally, the last segment is characterized by people who need to cover very short distance (within 3 km) by walking. "Pedestrians" are mainly composed of students who have moved away from home on purpose and showed the lowest average age. Being close to the Campus appeared the main reason for choosing their actual accommodation, probably because they are the group with the lowest percentage of people with access to a private vehicle as well as to a bike. However, their attitudes toward the latter mode of transport are quite positive. As for the "Two-wheeled urban users", they exhibited a stronger and higher perceived control over their behaviour for what concern the use of alternative modes of transport than the car as well as higher values about protecting the environment and preventing the detrimental effect of using the car. People who decide to walk to reach their destination are the most satisfied with and attributed the lowest amount of money to their time trip compared to other groups attributed. Overall, it might be that

short distance and low income (i.e., no access to a car or a bike) are the main factors influencing this modal choice as already highlighted by previous work (Adams, Esliger, Taylor, & Sherar, 2017; Panter, Griffin, Dalton, & Ogilvie, 2011). Given the proportion of people within this group who have experienced a disruptive event, the main reason why commuters walk to the University may be the result of their relocation. According to the habit discontinuity hypothesis (Verplanken & Wood, 2006), when the context changes occur, it may disrupt people's habits and a "window of opportunity" might open, giving people the chance to redefine their behaviours by considering other mobility patterns in a deliberate and rationale way. A better understanding of factors that can encourage walking to and from the workplace/place of study is encouraged, especially journeys where this mode is combined with other means of transport. In the present study, it was not possible to investigate this multimodal strategy. Nonetheless, "Pedestrians" distinguished themselves in a single homogeneous (unimodal) group.

The present study has some limitations that must be acknowledged. First, the study concerns the exclusive use of self-report measures, which may be subject to reporting bias, even though other previous research on this topic also used an online survey (Shannon et al., 2006). The cross-sectional design precludes from causality or chronological order of changes. Researchers should try to adopt and implement a longitudinal study design to better understand modal choices over a specified period. Moreover, the study is based on an extensive amount of data, yet reliability and validity need to be evaluated with attention. Cross-sample validation has been adopted to overcome misclassification in the classification tree analysis. The validation divided the sample into two subsets: one sample, called the learning sample is used to split the nodes and the second one, the testing sample, is used to validate the model and test the misclassification procedure.

Chapter 4. Perceived barriers to sustainable mobility: a qualitative approach

4.1 Introduction

Modal shift from private to more sustainable modes of transport is mostly recognized as one of the core strategies to pursue and promote in order to take action against climate change and its negative consequences (United Nation, 2015). Road transportation policies adopted in Europe to reduce car use have led to some improvements. However, substantial challenges remain, and more significant impacts on health and environment still need to be achieved. In this respect, the increasing reliance on cars among people raises concerns about human sedentary lifestyle and its adverse effects on health (Gärling & Friman, 2015) which can be particularly harmful to older adults. Finally, car use is strictly related to the societal costs derived from traffic congestion, road accidents and injuries (Albertsson & Falkmer, 2005). The success of initiatives in reducing personal car use through behavioural change will mostly rely on the ability to persuade the community to use public or active modes of transport, especially for commuting (Van Acker et al., 2016). Within this framework, a line of research has been focused on exploring attitudes, perceptions and motivations of travel behaviour from a qualitative perspective.

Understanding the patterns underlying commuter travel behaviour is a complex field of research, however using a qualitative approach it is possible to obtain essential inputs regarding the attitudes and perceptions of users for different transport options available today (Berião & Cabral, 2007). This approach has the potential to highlight and deepen the understanding of the triggers and barriers that characterize the decision-making process of travellers when it comes to modal choices. For example, a qualitative study by Hagman (2003) showed that those who often use the machine attribute positive qualities such as the possibility of moving more flexibly, without the need to respect fixed times, as well as the possibility of saving time, which would otherwise

be lost when using public transport. However, through a qualitative approach, it was also possible to bring out negative aspects related to car use in one's travels, such as the costs associated with its use, as well as a general concern about the adverse effects on the environment. After all, however, these same people, although aware of the need to reduce their car use, were not willing to change their behaviour. Another qualitative study carried out through focus groups with road users compared the way people talk and discuss public bus transport with car use (Guiver, 2007). The results of this study have made it possible to highlight some social constructions over the bus, such as fears of getting on a dirty, crowded bus, as well as never knowing with certainty whether the bus will be on time or not. At the same time, however, through the focus group it was possible to reveal that for coach passengers coming from rural villages on the outskirts, the bus is depicted as a pleasant way to socialize with the other inhabitants of the area. Likewise, the study highlighted the social constructions regarding the car, such as the comfort and privacy given by the car cabin. The control people can have over their travel time as well as the high costs necessary to maintain a car. Costs perceived as acceptable in comparison with the efficiency and costs of public transport.

The most noteworthy aspect of this study was looking at the differences in ways of telling and talking about the bus for regular users and non-users (or observers). Observers, for example, perceived this mode of transport as useful to reduce congestion, available for people less fortunate and an easy way of get people to the city centre. However, although described positively, they did not adopt this mode of transport. Another study from Gardner and Abraham (2008) identified core aspects for using the car to go to work by conducting semi-structured interviews. Results highlighted minimising journey time, financial expenditure as well as physical and psychological effort as reasons to support the use of the car. Other motives for using the car might depend on the attachment to cars or the status achieved by owning a private car (Berião & Cabral, 2007).

Furthermore, the desire for control over the transport experience, the opportunity to create a personal space were considered by participants as other valid motives to use the car. Another qualitative study (Guell, Panter, Jones & Ogilvie, 2012) showed how commuters' mode choice is influenced by several factors such as changing in life events (e.g., became a mother, changing job or moving to a new house), as well as changes in everyday life (e.g., traffic accidents). Finally, commuters' travel behaviour has been seen to be also influenced by individual determinants as well as organizational practices such as parking restrictions or financial incentives when using public transport services (Lo et al. 2013).

In the present study, the main aim of the research was to investigate, through a qualitative approach, the perceptions and motivations underlying the modal choice of an academic community. Indeed, universities significantly contribute to the traffic (Khattak et al., 2011), also because they often represent a critical actor in the cities where they reside for the number of employees/students involved. As already suggested by Xiao, Liu and Wang (2018), understanding the key determinants among the academic community may help in reducing the use of private cars and promoting a modal shift with the chance to develop tailored organizational interventions towards sustainable mobility. As a matter of social responsibility and institutional sustainability (Whalen et al., 2013), universities can take the opportunity to provide leadership in the field of sustainable transportation (Balsas, 2003). The study explored triggers and barriers as well as the role the institutions may play in shaping commuting modal choice.

4.2 Materials and Method

4.2.1 Procedure

Data collection started after approval from the Ethical Committee of the University of Bologna had been obtained. The survey was conducted using a web-based online questionnaire

addressed to three different groups within the organizational context: (i) students, (ii) professors, and (iii) university staff. A link to the online questionnaire was also published on the website of the University Mobility Service, where participants could access information about the purposes of the research, data protection, and privacy issue statements. The link was sent using university emails.

4.2.2 Participants

Since the last census carried out within the University of Bologna (Unibo, 2016), the university community has a total of 84,724 students, of which 5,376 from international courses and 4,161 enrolled in post-graduate courses. As far as teaching and technical-administrative staff (TA staff) are concerned, since the last report, a total of 2,819 teachers have been registered, of whom 994 are researchers, and a total of 2,945 are administrative staff. At the end of the survey, 11808 people decided to join the survey by filling in the questionnaire whereas 1098 participants responded to the open question placed at the end of the questionnaire, thus being the actual sample for this study. Of these, 575 (52.4%) were female (with 4.1% as missing values). As expected, the sample is composed mostly of students, precisely 64.0% of the sample. Most of them are young students who have left their hometown to undertake, continue or conclude their university path (32.6%). The administrative staff of the University represent 16.2% followed by professors (12.8%) and all those personnel directly involved in different research activities under project contracts, research grants or scholarships (7.0%). The sample average age is 30 years old (SD = 13.59). In general, academic commuters covered an average distance of 30km (SD = 41.16). The primary strategy used to reach the workplace/study is the bus, with about 17.3% of the sample that combines the walking mode to reach the bus stop or the Campus once reached the bus stop closest to it. Cycling respondents accounted for 12.8%, followed by about 11% of people walking to their

destination. As far as private transport users are concerned, about 17% use the car to cover the whole journey, while about 10% use the car to reach the railway station needed to cover longer distances.

4.2.3 Procedure and qualitative analysis

This study is based on the previous work (study 2) in which the ad hoc questionnaire created included an open question on personal experiences and mode choices. The area dedicated to the participants' comments was designed to gather attitudes, motivations, perceptions or concerns of the academic community about sustainable mobility in general or about the reasons for adopting a specific travel chain strategy.

Following a qualitative approach, an inductive grounded theory analysis has been conducted, and each participant's comment was analysed to highlighting the central theme discussed within it. The grounded theory approach based upon inductive analysis mainly entails a detailed reading of the raw data without explicit adherence to hypotheses or theories identified or constructed by the researcher. In other words, the raw text analysis aims to derive codes, concepts, themes as well as a framework through the interpretations made by an evaluator or researcher from the raw data. In the specific case, the analysis process has been set up using an independent parallel coding. Codes, labels and categories were refined through a repeated inspection by two previously trained researchers, with a third researcher involved if a joint agreement was not reached. First, the data has been faithfully reported in a word document to facilitate the analysis of the text. This step uses a series of systematic encodings, thus giving meaning to the data. The data is fragmented and examined in an iterative manner to be conceptualized, compared and categorized into conceptual labels. Following the work previously carried out by Banerjee and Hinelo (2014), given the high amount of participants' responses (n=1098), the aim of this study was to highlight the

interrelationships between the key points of the selected concepts rather than a microanalysis fragmenting the data into single words.

Two researchers carried out a first analysis of the comments and developed a series of codes that constitute the preliminary labels (open coding). The two researchers analysed 50426 words in total and the open coding process produced a total of 1354 codes. Of these, 385 codes were disregarded because they addressed the pros and cons of the questionnaire as a tool used for the survey. The analysis of the codes made it possible to create 43 labels initially categorized into 9 themes. In detail, participants' statements were initially provided with several provisional concept codes in the open coding process. Demand management of public transport, comfort, punctuality, effectiveness and quality of service, number of lines, night or ad hoc routes, reasons and positive attitudes for car use, parking issues, family needs, considerations on discounts and benefits, reasons for cycling, level of infrastructure and cycle paths, incentives for e-bikes, integrated mode policies were among the most frequent concepts. In addition, the role of the University in encouraging and promoting sustainability in both modal and organisational behaviour, the problems of non-resident or long-distance commuters, the need for synergies and actions at policy level, sharing mobility as a service, choice of accommodation and mode were among the other labels that emerged. A further open codification refined and compared these concepts in order to develop broader categories through an axial codification based on highlighting the essential aspects of the main transport modes, as well as the contextual factors involved in the choice of mode. Therefore, nine general categories were created: public transport system; car use; bicycle use; sharing mobility; benefits and discounts, role of the university, role of local and regional political authorities, housing issues, non-resident academic population). After, the core categories were identified in the selective coding process, which explained how these categories

were interlinked. In particular, the main objective of the selective coding process was to highlight the main links that explain the barriers and triggers that could favour a modal shift towards more sustainable modes of transport, while discouraging car use. The analysis of the relationships emerged between sub-categories and categories led to the definition of a conceptual framework composed of 4 over-arching central themes which addressed the perceived barriers in the use of public transport, the perceived constraints in the adoption of alternatives to car use, the perceived barriers in cycling and walking; and the environmental and organisational factors that could facilitate a modal shift. The general list of codes, labels, categories and main themes is available in the Appendix (Table 11).

4.3 Results

One of the main themes addressed by the participants refers to the perceived barriers in the adoption of public transport for the commuting mode choice. In addition, people reported a desire for more facilities or discounts when subscribing to public transport. Another interesting topic that emerged from the analysis is related to participants' reasons and motivations for choosing their car for the commuting trip instead of a more sustainable mode of transport. Cycling and walking were also taken into account by respondents who describe their attitude towards these active modes of transport or their expectations in terms of infrastructure improvements. In addition, one theme was linked to environmental and organisational factors that may encourage the adoption of a more sustainable travel behaviour. In some cases, environmental and organisational factors refer to a political intervention, in which the actors involved are expected to provide collective responses to the problem in question. In terms of alternative modes of transport, sharing mobility emerged as a topic to discuss. Finally, participants tended to discuss how their choice about where to live had an impact on their home-work movement.

4.3.1 Perceived barriers in the use of public transport

Participants identified specific barriers in the use of public transport. In specific, they mentioned the comfort and quality of buses, the timing and effectiveness of the service used, their willingness to access additional routes, including night-time connections or ad hoc routes to reach some university locations located in remote areas. Some participants identified as barriers the lack of reliability and effectiveness of the public service.

"Moving from the suburban areas takes a long time and is heavily affected by traffic. I have been late for class several times because the bus was late."

"As regards public services, they are often late and do not always comply with the timetables."

"The bus is no longer a useful mode of transport for young people because it is too slow and unreliable."

"I would be willing to increase my use of the bus to reach my workplace if the timetables were respected (I have had truly negative experiences in this regard)."

Some participants underlined their negative attitudes towards public transport due to a lack of connections and limited provision of routes.

"I am in favour of sustainable mobility. The problem is that there is often a lack of means or inadequate means of transport (buses are often late or do not respect travel timetables), which can continue to encourage the use of cars by many people."

"I wish it would have been better bus connections. I had to walk 40 minutes a day with cold and bad weather conditions."

"I live in a suburban area, and public transport runs every hour, so for me, it is impossible to reach the workplace by using it."

The low quality of the service offered, and the lack of comfort associated with the use of public transport has been reported as significant travel constraints in the decision-making travel mode choice among participants.

"Often, buses are not equipped with platforms for people with disabilities or the elderly, unacceptable. Also, there are steps to reach the seats that prevent the elderly from getting on safely, forcing them to stand in overcrowded and unstable buses, as drivers drive recklessly and often not respecting the rules of the road."

"I am quite upset about this service because during peak hours there are 50 people aboard a tiny shuttle bus. I think it is not comfortable but especially dangerous."

"Both trains and buses are not adequate (in size and frequency) for the number of people who use them and you find yourself almost every day to face a journey by bus crushed like sardines (or if you prefer on a cattle wagon) and a train journey standing for 65km after an entire day of work/study. Then you could add other problems: air conditioning, seating, lack of space for legs and suitcases."

Participants identified some negative aspects associated with rail services.

"This year I used the train much less (then using the car) because it was often late, overcrowded, dirty. Often, I do not feel safe, and so I try to sit where there is someone who makes me feel calm."

"Bus schedules are not always respected. Sometimes it happens that you miss the train when returning from university or arriving late at university. As a result, there is uncertainty."

"A bus and train service even at night would make it possible to avoid unnecessary pollution, but for those who do not live in the city centre there is no alternative to the car in the evening at the moment."

Participants expressed their thoughts on the possibility of taking advantage of benefits or discounts in the use of public transport. About one out of two participants offered arguments, both positive and negative, about to public transport subscriptions, while others preferred to draw attention to the possibility of extending these benefits to specific groups (PhD students, students above the age limit, i.e., 26 years, eligible for these benefits). Other considerations concerned the need to make readily available the information required to benefit from these incentives. In addition, some participants reported the possibility of encouraging the use of "integrated subscriptions" and ultimately intermodality.

"Since I bought a bus subscription at a reduced rate, I use the bus almost all the times instead of the car. I use the car only for emergencies and family duties."

"The facilities for purchasing public transport season tickets are beneficial and undoubtedly encourage the use of the bus."

"Junior researchers are excluded from the benefits of permanent personnel. It is necessary to extend these facilities to this category, which is increasingly present in the university."

"Facilities for public transport are a good innovation, but it is not advertised at all, and I discovered it through personal research."

"I thank the university for the possibility of obtaining an integrated subscription (train + bus) because it encourages the use of public transport in all travel circumstances."

4.3.2 Perceived constraints in the adoption of alternatives to car use

Participants identified constraints in the adoption of alternatives to car use. Some participants highlighted the advantages of car use in terms of flexibility, efficiency or comfort, especially when comparing car use with the use of public transport. There are also personal constraints (e.g., family needs) which may force the use of the private mode of transport.

Participants distinguished between the advantages of private transport over public transport, which is perceived as expensive and often inefficient, and the lack of convenient connections with local public services, which are often too far from home.

"As long as transport by public transport will expensive, slower and unreliable I will be forced to use the car. Living far away (25km) I need to have a safe, reliable and comfortable vehicle, and for me, the car meets these needs."

"I understand the importance of sustainable mobility, but if you live too far away to think about your home-work-to-home route by bike (just think about the danger of the vehicle or the weather problems) and if you have had enough of the public transport, dirty, overcrowded and infrequent, the car remains the only option to maintain a good quality of life. Therefore, I believe that car users should not be demonized or even discouraged because they are not doing so because of laziness or environmental disinterest. Especially now that there are solutions to natural gas, LPG and especially electric/hybrid that combine convenience and respect for the environment."

"Living in a town without a railway station and with a few bus lines, I chose the car to reach the university because the expense is similar, but the journey time is more than halved."

Within this theme, participants expressed their concern about the lack of parking areas near the university facilities as well as the related cost of parking,

"The main problem is that you waste too much time looking for parking. So, if it takes 40 minutes to get there by car, but I lose 15/20 minutes to find the parking space, in the end, my trip takes almost an hour."

"Many teachers need to move between different premises during the day, often far from each other. The car allows you to move easily, but the departments do not have enough parking slots."

At the same time, others offer different perspectives on the parking availabilities.

"We must encourage the use of sustainable means and discourage the use of the car, also given the unsustainable situation of parking where work, cars are parked everywhere!"

"Parking for students with medical problems unable to use public transport."

Finally, among the reasons that force people to choose the car as the primary mode for their home-work trips, participants reported the presence of family duties or other personal needs that somehow guide their choice.

"The use of the private vehicle is linked to the need for a woman to manage her work and her family, or more precisely her children, take them to school, sport, shopping, and thus optimizing the travel to reach the workplace."

"I always came by bus to work, but since I have two young children, I can no longer organize my schedules, and I have to take the car, although very unwillingly."

"I have a disability that limits my movements."

4.3.3 Perceived barriers in cycling and walking

Participants focused their attention on various actions deemed necessary to promote an increasing adoption of this sustainable means of transport. For example, some participants stressed the need to strengthen infrastructure, such as the increase of cycle paths. Also increasing parking lots, possibly guarded to combat the scourge of theft of bicycles have been reported. Incentives for buying electric bicycles and greater synergy with public transport to promote the adoption of an integrated modal strategy are other theme extrapolated from the analysis.

The section dedicated to the use of the bicycle reports a series of considerations on the need for a significant investment in infrastructure, with a specific reference to a strengthening of cycle paths as well as the need to invest in secure parking areas to prevent the age-old issue of bicycle theft (and its illegal market).

"I would like to bike, but unfortunately the chaotic road network and the absence of bike paths in the home-work route prevent me from doing so. Only a widespread network of bike paths separated from the car traffic can improve the situation."

"The bike is fast, and I like it. Nevertheless, in this city, it is scaring. There are few bikes paths."

"The problem of cycle paths is their riskiness, which often discourages their use: narrow, with right angle curves, sometimes interrupted."

"I would love to use my bicycle to go to Bologna (I would save 30 minutes every day), but I do not do it because I fear they will steal it from me."

"The other factor that would make my trip more reasonable would be to have safe places to park the bike, without the fear that it might be stolen."

The possibility of taking advantage of discounts or incentives for buying bicycles, in particular electric bicycles are some of the responses stressed by participants. The desire to benefit from more and better cycling infrastructure and the potential opportunity to facilitate intermodal transport are another example reported by participants. Finally, some participants reported some insights about going to work on foot. For example, educational programmes to promote safe and sustainable behaviours among the various stakeholders have been suggested by a few participants.

"I would like to see more incentives for cycling, for example, by designing changing rooms with showers in the workplace."

"Incentives would be needed for the long-term purchase or rental of e-bikes".

"The pedestrian zone should be extended to the entire centre of Bologna."

"I have problems getting around on foot. In the university area, there is a risk of being or bothered by drunk people."

"Community education programmes on road behaviours - including pedestrians - would help to encourage the use of active modes."

4.3.4 Environmental and Organisational factors

The potential role of the University in encouraging and promoting sustainability both at the modal behaviour level (e.g., routes between different locations, flexibility of lesson times) and the organizational level (e.g., incentives and strategies for its staff, bottom-up strategies of

involvement, telework) has been reported, such as to spread a broader sense of belonging to an institution perceived as increasingly "green". Within this category, a joint work between political stakeholders potentially interested in sustainable mobility is also advocated by participants, while few of them proposed stricter sanctions to combat the use of private transport, especially in the city centre.

Participants reported their satisfaction with the work done by the organization or opinions about the possibility to further develop such initiatives.

"The improvement of sustainable transport can be achieved in synergy with local and regional public institutions."

"I believe that the University could help the Municipality in the design of better traffic environment."

"Advocate restricting the transit of car in the city centre".

"I think that the University should not only encourage the use of sustainable mobility but also become more "ecological": water stations, bottle recycling stations. The University is enormous, with many students, we could make a difference."

Participants also mentioned incentives for the use of sustainable modes and the scheduling of academic classes in remote premises considering timetables.

"I think that the university should develop agreements with the Italian railways to promote more flexible timetable."

"I believe that we should take greater account of commuting students by better managing the schedules of certain activities allowing for greater flexibility of schedules."

The implementation of participatory decision-making strategies from an organisational point of view, more significant organisational support for trips between University premises carried out on the same day, new policies for business trips abroad, the introduction of corporate awards for who adopt sustainable modal strategies and the promotion of teleworking or videoconferencing are other examples reported by the participants regarding the role of the organisation.

> *"The main problem is related to travel between different premises. It is not possible to walk the distance, and not everyone is willing to travel by bicycle, for various reasons. This is a major problem for people from outside the city without a proper mode of transport."*

> *"It is necessary to support remote work (as far as possible) as the university has started to do with teleworking or with access to decentralized workstations."*

> *"It would be nice to raise awareness sustainability in general, welcoming and implementing projects. Creativity, efficiency and collaboration are needed for a more cohesive society.*

Participants mentioned the pros and cons of bike-sharing and car-sharing programs. In particular, they stressed the need to make these services available outside the city centre.

> *"The network of car/bike-sharing services should be widespread and efficient. Otherwise, the population will never have a valid reason to change habits".*

> *"For those who have annual subscriptions to public transport, there should be discounts or should be included a bike-sharing subscription."*

Finally, the difficulty of finding accommodation with affordable rent or not too far from the primary place of study/work has often been reported by respondents as an essential issue in the adoption of sustainable transport solutions. In general, the choice of accommodation seems to have a significant impact on the modal strategy adopted, mainly by students.

> *"My discomfort is not so much related to mobility at the structural level but to the time needed to reach the university, which is excessive and physically and mentally exhausting. A lack of university housing fosters this situation."*
>
> *"The real problem is the accommodation issue for students away from home. Transport can be improved endlessly, but if a student finds himself or herself too far away, it is always difficult to reconcile study, lessons and private life".*

4.4 Discussion

The present qualitative study aimed to identify perceptions and motivations underlying the modal choice of an academic community. Specifically, the open question included at the end of the questionnaire crafted for the previous work (study 2), made possible to collect opinions and concerns, thus highlighting triggers and barriers about sustainable mobility in general or about the reasons for adopting a specific travel chain strategy. The grounded theory analysis allowed to identify core categories influencing commuters' mode choice.

One of the main themes addressed by participants refers to the perceived barriers in the adoption of public transport for the commuting mode choice. Timing and a lack of adequate number of routes to properly satisfy the academic community's mobility needs is one of the main constraints for choosing public transport as the main mode of transport on the home-work trip. As already confirmed by previous research, the level of neighbourhood connectivity (Chng, White, Abraham & Skippon, 2016) has an impact on public transport use as well as on user satisfaction

and mental distress. Indeed, in our sample, frustration from unreliable service, negative experiences and failure to meet individual mode demand may encourage people to switch to the car. In this regard, improving service quality by providing real-time travel information to travellers has been seen to positively reduce scheduling cost (Ettema & Timmermans, 2006), thus making this mode choice more attractive and reliable. This negative attitude towards public transport is further underlined by inadequate cleanliness and comfort perceived along the way for bus users. The role played by instrumental motivations (i.e., comfort, accessibility, reliability) of public transport in attracting car users has been highlighted by previous studies (e.g., Şimşekoğlu et al., 2015).

The perceived value in choosing the public transport, if disregarded, can only discourage the use of this mode, further aggravating the environmental context. If the choice to use public transport is forced by long distances to be covered or by the absence of a private car, it will create the basis for a dissatisfied user who will change mode as soon as one of the conditions is resolved (for example by buying the car). Therefore, it is a priority for the stakeholders involved to offer at least a service that allows people to use comfortable, clean and spacious means if the use of this mode should be encouraged. Nonetheless, public transport users who can take advantage of the time available for other activities, whether for work or leisure, declare a higher level of satisfaction and a lower value for their time (Ettema, Friman, Gärling, Olsson, & Fujii, 2012; Line, Jain & Lyons, 211). Dissatisfaction has also been noted in those who come from the suburbs. While in previous studies users from the suburbs have experienced public transport positively, as a place of socialization (Guiver, 2007). According to the results of this study, an essential condition emerges for such an experience to take place, namely the presence of a widespread network able to provide services even in the most remote areas. Otherwise, the person may continue to prefer the car when

travelling. In other words, when it comes to investing in the public transport system, it would be better to favour areas outside the city centre, since the latter is already well served. Furthermore, it would avoid further congestion of urban traffic.

Findings and implications on public transport are further corroborated by what participants reported on car use. Lack of public transport connections has been reported as one of the main reasons for preferring the car. Furthermore, flexibility, efficiency and comfort, especially when compared car use with the use of public transport, are among the significant advantages perceived by participants. Several studies have already highlighted positive attitudes towards the car (Anable, 2005; Steg, 2005), even when faced with higher costs (Gardner & Abraham, 2007). Moreover, bearing in mind the concept of habit, when a modal choice reveals itself to be successful in responding to one's own modal needs, the person will tend to develop a tendency to reproduce this choice also in the future. The role of habits in the modal choice is widely documented (Verplanken & Roy, 2016; Verplanken, Walker, Davis, & Jurasek, 2008; Walker, Thomas, & Verplanken, 2015). By combining motivations, attitudes, perceptions and habits in such a scenario, the possibility of inducing a modal shift becomes even more complicated. However, interesting insights are provided directly by a few participants who suggested a series of possible interventions or beneficial policies to reduce car use.

Reducing parking spaces available near the study/work sites as well as increasing parking costs (albeit unpopular) could be a practical strategy in discouraging users from using private vehicles (or at least encouraging the use of cars in a shared way to reduce overall costs). Other studies have already highlighted how this strategy can contribute to more sustainable mobility when combined with other policy measures (Pucher & Buehler, 2008). For example, while the previously car parking area could be converted into a secured and guarded bicycle parking area,

new parking spaces could be created not far from the city centre, with reduced prices and related reductions in using a bike-sharing service that would bring the person closer to the University. Such a strategy would meet two specific requests arising from the qualitative analysis. On the one hand, it would encourage cycling by providing secured parking and eliminating the risk of theft (one of the main obstacles identified). On the other hand, it would avoid the introduction of private vehicles in the city centre, which would reduce urban traffic, improve air quality and at the same time provide more space for pedestrians (e.g., car-free pedestrian zone; Bueheler, et al., 2017).

Among additional interventions, providing discounts or incentives for purchasing subscriptions to public transport, buying e-bikes, as well as for using shared mobility, is the dominant strategy that emerged from this study. Apparently, without the perception of a lower cost to start adopting or maintaining a different style of commuting behaviour than the car, the person finds a modal shift problematic. This challenge is further amplified if the person exhibits a strong habit in driving (de Kruijf, Ettema, Kamphuis & Dijst, 2018). In this respect, it should be mentioned that in our study, most of the sample is represented by students. Therefore, the economic component of participants should not be excluded as one of the factors influencing this standpoint. At the same time, also professors and especially administrative staff reported similar feedback.

Besides, the University might be the main actor promoting sustainable mobility behaviours. Indeed, as already stated in previous research (Bamberg & Schmidt, 2001; Dagiliūtė, Liobikienė e Minelgaitė 2018; Dubuy et al., 2013; Nakayama & Takayama, 2005; Page & Nilsson, 2016) organisational factors may provide the contextual and instrumental basis for the adoption of a more sustainable travel behaviour. Some of the possible strategies that the institution can adopt to promote more sustainable travel behaviour are corporate awards for who, after registering at the corporate competition, proved to travel many miles as possible with sustainable means. Also,

loyalty programs or information kits regarding available discounts or routes to be travelled sustainably. Another strategy might be encouraging the academic community to design events or interventions to make the workplace/study greener. Moreover, the need to support families in their daily movements is an attractive field of research in which to explore possible ways of intervention. According to the results and previous studies, the presence of family obligations (e.g., children) in encouraging the use of the car is a crucial factor (Kim & Ulfarsson, 2008; Whalen et al., 2013).

Finally, participants tended to discuss how their choice about where to live had an impact on their home-work movement. For example, Zhou (2012) highlighted a tendency for students living alone to use their private cars, while being close to friends or colleagues makes sustainable transport use more attractive. The role of the university in shaping commuter behaviour among university students could be possible through greater accessibility to students' housing. Ensuring that these accommodations are easily accessible by sustainable means will increase the chances of reducing car use.

This study has a few limitations. First, the response rate of the study was low and, considering the descriptive of the overall academic population and the findings could not be considered representative of this Italian academic organization. In addition, the qualitative study stems from the chance to analyse the answers provided voluntarily by participants to the open-ended question posed at the end of the questionnaire. Therefore, a guided interview or a focus group was not set up to investigate specific research questions, as was the case in other studies. Future research could analyse in more depth the dimensions that emerged from this study to bring out further insights in (1) the decision-making modal choice process or (2) developing new policies to be adopted to reduce the use of the car. Furthermore, researchers should try to adopt and

implement a longitudinal study design to better understand modal choices over a certain period and be able to uncover reasons and motivations that might foster a modal shift.

Chapter 5. How attitudes, perceived level of service and mode choice shape the value of time

5.1 Introduction

In the present study, we intended to deepen our knowledge on how time and space are relevant factors of transport mode (Walle & Steenberghen, 2006) and how psychosocial variables shape and define our mobility choices. Mobility choices reflect users' beliefs and perception, attitudes towards different means of transport, habits, subjective and objective constraints, therefore scientific literature refers to the topic with the term "travel behaviour" (Ben-Akiva et al., 2002), a definition encompassing both knowledge on traffic, built environment characteristics as well as social and psychological aspects concerning decision theory. However, in transport economics, the value of time (VOT) has received significant attention because it constitutes a measure to justify investment in transport schemes, both as a reliable driver for investments in infrastructure for car traffic as well as to incentivize the use of sustainable transport modes.

The value of time, which can be defined as the amount of money that a user is willing to pay in exchange for an hour of reduced travel time, has been considered a key input to better understand travel demand patterns and to guide decisions in terms of investment and transport management strategies to foster sustainability (Athira et al., 2016). Within this line of research, the focus has been on the university context, explicitly taking into account the commuter community. Indeed, universities significantly contribute to the traffic (Khattak et al., 2011), also because they often represent a critical actor in the cities where they reside for the number of employees/students involved. Particularly relevant for commuters, time is a critical dimension in comparing and selecting the most efficient modes of transport. However, considering the commuters' category, the results are inconsistent. In some studies, the VOT of commuters moving

by car is higher than in public transport, in other studies the estimates are lower compared to rail transport users (Shires et al., 2009; Abrantes et al., 2011).

One of the possible reasons could rely on the methods and statistical procedure used to explore VOT distribution among transport users (Li, te al., 2010; Shires et al., 2009; Zamparini et al., 2007). Most of the studies have mainly focused on using variables such as salary, the reason for travel, GDP, region, mode, trip length, while relevant psychosocial variables used to predict travel behaviours such as PBC, have hardly been considered. In this respect, it is interesting to mention the study carried out by Abou-Zeid , Witter, Bielaire, Kaufmann, and Ben-Akiva, (2012) who have demonstrated the influence of personal attitudes towards travel as one of the factors which can explain the variance in the VOT, along with demographic and travel characteristics. In conclusion, to the authors' knowledge, there are no studies that have considered the role played by psychosocial dimensions of commuting mobility choices on the value of time. Therefore, the main research questions of the present study are addressed as follow:

RQ: How do the psychological and social factors together with the commuting modal choice influence the value of time among university commuters?

5.2 Materials and Methods

5.2.1 Procedure

The academic community participated in the online survey through a link sent by email. Participants could also access information to the online questionnaire through the University Sustainable Mobility webpage where other relevant information such as the purposes of the research, data protection, and privacy issue statements were published. The Ethical Committee of the University of Bologna approved the study. To improve the functionality and quality of life of the university community, the University has established five campuses in the central provinces of

the Region (Bologna, Forlì, Cesena, Ravenna and Rimini), where distances of up to 300 km are included. These urban cities, where the academic population is an essential part of the population of that urban area, are well connected by highways and railways as well as by regular bus services.

5.2.2 Participants

A total of 11,773 participants from the academic institution fulfilled the questionnaire. Data from participants who not responded to most of the scale of interest or did not complete the questionnaire were eliminated, leaving a sample of 8,743 participants (9.66% of the population surveyed) included in the analysis. Of these, 3,246 (37.2%) were male, 5,219 (59.7%) were female and 275 (3.1%) were missing value. The age of the participants ranged from 17 to 77 years. The mean for resident students (N = 2,137; 35.8%) was 21.73 (SD = 5.49), the mean for non-resident students (i.e., who had to move to follow their studies; N = 3,550; 40.6%) was 21.63 (SD = 4.63), the mean for professors' collaborators (N = 402; 4.6%) was 30.69 (SD = 9.60), the mean for professors (N= 670; 7.7%) was 48.68 (SD = 9.35), the mean for staff (N = 994; 11.4%) was 47.19 (SD = 8.45) whereas the general mean value was 26.91 (SD = 11.85). As for the total distance travelled to and from the University, in general, the sampled population covers on average 28.14 km (SD = 39.79), with a minimum of 0.1 km and a maximum of 388.50 km.

5.2.3 Measures

Participants filled out a web-based questionnaire with sets of scale and multiple-choice questions. The questionnaire contained questions on demographic information such as age, gender, academic status (i.e., home students, students away from home, professors, staff), and nationality. Other areas included information about attitudes towards public transport, perceived behavioural control, personal satisfaction of the level of service, a detailed description of their own commuting

trip chain that has been used to calculate the level of CO2 emission and, finally, the perceived value in money associated with the time needed to reach their final destination.

Perceived behaviour control (PBC). The scale from Klöckner and Blöbaum, (2010) explores the degree to which perceived behavioural control and subjective constraints affect the mode choice in favour of car use with three items (e.g., "*It would be difficult to manage my frequent trips with environmentally friendly means of transportation"*). Participants were asked to express their degree of agreement with each statement on a 5-point Likert scale ranging from 1 = completely disagree to 5 = completely agree. Cronbach's alpha was .767. The composite score has been reversed to facilitate the interpretation of results, that is the higher the value of the scale, the more the participant perceives the use of alternative means to the car as a reliable option. About the meaning of "environmentally friendly means of transport", the questionnaire did not specify what kind of modes were intended (e.g., using a car with renewable/alternative fuels, carpooling), thus partly limiting the responses of the participants.

Personal Norm (PN). Participants were asked to express their degree of agreement to car use reduction and its effects on environmental quality. One item from Klöckner and Blöbaum, (2010) has been used: *"When I have to choose which means of transport to take, I always try to use a sustainable mode of transport"*). Respondents evaluated on a 5-point Likert scale ranging from 1 = completely disagree to 5 = completely agree.

Attitudes towards Public Transport (ATT-PT). To measure participants' attitudes towards the use of public transport, participants responded to 16 items, each one evaluating a specific characteristic of either the train or the bus alternatives. An example of items was "*Considering the bus/train, how much do you consider this mode of transport as relaxing/reliable/fast"*. Participants were asked to respond using a five-point scale ranging from 1 (not at all) to 5 (very much). We did

exploratory factor analysis to investigate the dimensions of positive attitudes towards public transport, using principal axis factoring followed by quartimin rotation. The analysis indicated a one-factor solution. A total of 43.1% variance was explained by exploratory factor analysis. Absolute factor loadings greater than 0.50 were considered salient. Four items (i.e., *"how much do you consider the bus/train as economic?"* and "*how much do you consider the bus/train to be at risk of an accident?"*) were dropped because of their low factor loading. The one-solution factor was about positive attitudes towards the use of public transport. Cronbach's alpha for the one-factor was .866. In Kouwenhoven and de Jong (2018), an extensive literature on the relationship between travel time and perception is discussed, showing that people who indicate that trip duration is very inconvenient to have usually a higher value of time.

Perceived Level of Service (P-LOS) is a quality measure describing a system's operational conditions under certain service circumstances (for example, the delay at a signalized intersection or the crowding per surface unit onboard vehicles or at a target transport terminal sub-system). The quality measure reflects the system's status in terms of, for example, comfort and convenience. In the present study, three items on a 5-point Likert scale were intended to assess participants' satisfaction in terms of perceived safety during their trips, the perceived quality of the infrastructure and the level of accessibility by means of the following question "*In more detail, from 1 (=not at all) to 10 (=completely), how much are you satisfied with the following aspects of your home-University trip?".* Cronbach's alpha was .805. The level of perceived comfort has not been included in the analysis because, as suggested by Kouwenhoven and de Jong (2018), when being investigated in a methodologically and conceptually correct way, it should be compared with the reduction of benefits in terms of time, which is not the focus of the present work.

Unsustainability Index (UI). Participants were asked to describe their trip chain to and from the university in terms of travel mode used and perceived time and distance. Instead of registering each daily trip through a travel log diary, participants were asked to describe the most ordinary commuting trip. For each data obtained, the level of CO2 emission within the whole daily commuting trip chain has been derived by introducing – to better fit the analysis purpose - an "Unsustainability Index (*UI*)", which is the weighted sum of the product between the percentage of the trip chain carried out by the transport mode (p_i) and the corresponding unsustainability weight (w_i) associated to the transport mode. The w_i values are the values of emission coefficients of each transport mode taken into account in this study, normalized regarding the most carbon-neutral mode considered. The unsustainability weight associated with the pedestrian is set equal to 1 and, the values of other transport modes are derived accordingly; thus, the bigger the w_i, the less sustainable the target mode. In table 1 below, the unsustainability weights associated with each transport mode are summarized, sided by consistent reference sources.

Table 7. *Unsustainability weights associated with each transport mode*

Transport mode	ei^* [gCO2/pax-km]	w_i°	Main references
Pedestrian	10	1.0	Duffy et al. (2013)
Bike	21	2.1	Blondel et al. (2011)
Light Rail Transit LRT	65	6.5	Hill et al. (2018)
Motorbike	70	7.0	Hill et al. (2018)
Bus	105	10.5°°	Blondel et al. (2011), Hill et al. (2018)
Car	271	27.1	Blondel et al. (2011), Hill et al. (2018)

* emission factor is the weight of pollutant emitted for each pax-km carried. As far as the pedestrian, bike, the motorbike is concerned, only one passenger is considered, while for the remaining transport modes average loading factors derived by literature have been used.

° values take into account the lifecycle cost of the target mode (production, maintenance, operation)

°° average composition of EU public transport fleet

For example, if a trip chain consists of 20% length travelled on foot and the remaining equally split between the private car (40%) and bus (40%), the coefficient of "unsustainability" is computed by the following formula (1):

$$UI = \sum_i p_i w_i$$

$UI = 0.2 \cdot 1 + 0.4 \cdot 27.1 + 0.4 \cdot 10.1 = 15.08$

According to the formula above (1), the coefficient ranges between 1 (when the trip chain is performed entirely on pedestrian mode) and 27.1 (when the trip chain is entirely performed by using the most unsustainable mode). Thus, the closer UI is to 1, the more sustainable is the trip chain. Given the fact that w_i values are specific, UI is dependent from mode-mix only, and irrespective of distance travelled.

Value of Time, VOT (€/h). We asked participants the following question *"Considering the total amount of time that you usually spend for going to and coming back from the University, which monetary value would you attribute to your time?"*. Participants expressed the amount in euros associated with the time dedicated to going to and from the University. The final value has been divided by the total time (in hours) needed by participants to carry out the displacement. In this way, the monetary value of travel time is obtained (in €/h). Apart from the relevance of this dimension, one of the crucial parameters which are imperative to rebate hereabouts is the modal choice. Likewise, individual mobility by car and public transport, also bike travel and walking have their associated value of time (Wardman, 2004; Börjesson & Eliasson, 2012 respectively, with VOT for cycling of as much as 11-16 €/hour on varying the presence of separate lane).

5.2.4 Statistical Analysis

We conducted the analyses using SPSS v.25. In our analyses, to investigate the influence of age and the trip chain distance covered (in km), of attitudes towards public transport, perceived

behavioural control, perceived satisfaction on the level of service, and finally of the unsustainability index on the value of time. In stepwise regression, the predictive variables are input into the regression equation one by one under statistical criteria (use probability of F < .10). At each step of the analysis, the predictor variable, which contributes the most to the predictive equation in terms of multiple correlation variation (i.e., R2 change) is inserted first. This process is carried on as long as no additional variables add anything statistically to the regression equation. According to this definition, the stepwise regression is aimed at identifying a relatively thrifty model (i.e., with a limited number of significant predictors at the specified probability level) that is generally congruent with the observed data.

5.3 Results

Table 8 displays the mean scores (and relative standard deviations) and the correlation coefficients. Cronbach's alpha coefficients are provided in parentheses on the diagonal as estimates of internal consistency which were acceptable.

Table 8. *Descriptive statistics and correlation between variables*

	M	SD	1.	2.	3.	4.	5.	6.	7.	8.
1 Age	26.91	11.85	-							
2 Total KM	28.14	39.79	.01	-						
3 PBC	3.28	1.14	-.02	-.33**	(.76)					
4 PN	3.57	1.03	.03**	-.09**	.27**	-				
5 ATT-PT	2.42	0.58	.08**	-.14**	.27**	.20**	(.86)			
6 P-LOS	6.26	2.11	-.01	-.22**	.27**	.06**	.37**	(.80)		
7 UI	8.40	7.41	.19**	.15**	-.52**	-.24**	-.14**	-.13**	-	
8 VOT	17.94	20.24	.26**	.04**	-.08**	-.00	-.05**	-.09**	.14**	-

** The correlation is significant at level 0.01 (two-tailed).

The mean responses obtained for the items belonging to perceived behavioural control, personal norms, and personal satisfaction were above the midpoint, whereas the attitude towards the use of public transport was above the midpoint. All the correlations were significant, except the ones between age and distance travelled, age and personal behavioural control, age and personal satisfaction as well as between personal norm and the value attributed to the time spent commuting. Before performing the stepwise regression, all variables considered in the study were tested in terms of normality, skewness and kurtosis following Gravetter and Wallnau (2014). In order to achieve acceptable normality distribution, a log 10 transformation was carried out for the variables that were not compliant with the standard threshold of skewness and kurtosis below the value 2. In contrast, for the variables that complied with the standard threshold, values were standardized in z values. Stepwise multiple regression was conducted to evaluate whether personal characteristics (i.e., age), psychosocial dimensions (i.e., PBC, PN, ATT-PT, P-LOS) and the trip chain adopted (i.e., total distance travelled, UI) were effective predictors of VOT for commuters. Results revealed a parsimonious model consisting of six factor which explained about 9% of variance ($F_{(6,5553)} = 87.301$, $p < .001$) as shown in Table 9.

Table 9. *Stepwise multiple regression model summary*

Model	R	R2	Adapted R2	SE coefficients	F	p
1	.277	0.077	0.077	0.41674	463.552	.000
2	.285	0.081	0.081	0.41576	246.492	.000
3	.289	0.084	0.083	0.41529	169.251	.000
4	.291	0.085	0.084	0.41511	128.515	.000
5	.292	0.085	0.085	0.41498	103.739	.000
6	.294a	0.086	0.085	0.41484	87.301	.000a

a Predictors: Age, PBC, ATT-PT, UI, P-LOS, Km

Dependent Variable: VOT

Table 10 illustrates the multiple regression coefficients and the related confidence interval. At step 1 of the analysis, Age was entered into the regression equation and was significantly related to VOT (b = 0.277; p < .001) indicating that older adults perceived the higher value of their commuting time. PBC scores did enter into the equation at step 2 of the analysis (b = -0.067; p < .001) revealing that participants with a higher level of perceived behavioural control (thus able to use transport modes other than the car) expressed lower values of their commuting time. Attitudes towards Public Transport scores entered at step 3 of the analysis (b = -0.049; p < .001) indicating that participants with positive attitudes towards the use of public transport, expressed lower VOT.

Table 10. *Stepwise multiple regression coefficients*

Model		Unstandardized coefficients		Standardized coefficients			95% CI	
		B	SE	b	t	p	LL	UL
6	(Costant)	-0.003	0.051		-0.053	0.958	-0.103	0.097
	Age	0.763	0.037	0.273	20.884	0.000	0.691	0.834
	PBC	-0.017	0.007	-0.039	-2.474	0.013	-0.030	-0.003
	ATT-PT	-0.017	0.006	-0.040	-2.850	0.004	-0.029	-0.005
	UI	0.049	0.017	0.051	2.945	0.003	0.016	0.081
	P-LOS	-0.015	0.006	-0.035	-2.447	0.014	-0.028	-0.003
	KM	-0.023	0.010	-0.037	-2.181	0.029	-0.043	-0.002

a Dependent Variable: VOT
Variable non included: PN

Unsustainability Index (UI) became part of the regression equation at step 4 of the analysis (b = 0.035; p < .05) showing that participants who adopt means of transport with higher pollutant level attributed higher VOT to the time spent on commuting. Personal Satisfaction score of satisfaction with the level of service entered at step 5 of the analysis (b = -0.013; p < .01) indicating that participants who are more satisfied with the safety, quality of the infrastructure and level of accessibility during their commuting trip declare a lower VOT. Finally, the total distance covered

to reach the University and come back home became part of the regression equation at step 6 of the analysis ($b = -0.023$; $p < .05$) revealing that participants who covered less km, expressed higher values in euro of their time spent commuting. Finally, PN did not become part of the model since it was not compliant with the statistical criteria (use probability of $F < .10$), suggesting the VOT is irrespective of the personal concern towards the use of sustainable transport.

5.4 Discussion

The main aim of this study was to gain insight into psychosocial and travel-related predictors of the value of time. The current study sought to reach an understanding of the variation in the value of time through the analysis of a university community's modal choices. Taking into consideration main psychosocial determinants from the relevant literature (i.e., age, perceived behavioural control, attitudes, personal norm, perceived satisfaction with the level of service) and extrapolating the unsustainability index from the description of the trip chain, it was possible to describe a multivariate model that can broaden the understanding of the value of time.

Results show that as age increase, people tend to estimate their travel time more highly in euros providing support for a recent of about differences in the value of time travel between Millennials and older adults (Malokin, Circella & Moktarian, 2017). A plausible explanation could be related to the type of means adopted by young people and the nature of activities they carry out during their trip. Indeed, as stated by Prillwitz and Bar (2011), the younger can be considered as “green travellers”, thus suggesting a mode preference for active and public means of transport. Time available during travel could be vital for public transport users. Young people might be more likely to maximize the usefulness of the trip using electronic devices (Wardman and Lyons, 2016). The use of IT devices might have a dual function of enjoying multimedia content (e.g., music, film, TV series) as well as to carry out activities related to their study plan or their work. This

aspect could be further supported, considering the elderly resistance and barriers towards the adoption of new technology (Czaja et al., 2006; Vaportzis et al., 2017). Moreover, since the mode choice, in particular the commuting one, is often linked to personal income (Zaho, 2013), older adults (i.e., professors and academic staff) who should have a higher income, may be more inclined to use the private car which, in turn, could lead to a higher value of their time given the costs of fuel, parking and traffic.

A higher level of perceived behavioural control is associated with lower estimation of time travel, suggesting that people who perceive the concrete ability to perform a specific behaviour (i.e., use of alternative means of transport to the car) seem more inclined to allocate time to their movements. Accordingly, participants who exhibit positive attitudes towards the use of public transport also expressed a lower value of their time travel. On the contrary, personal moral obligation towards the use of alternative modes of transport than the car seems not affecting the amount of money that a user is oriented to pay in return of an hour of travel time reduction. In general, it is well documented the role played by PBC and personal values as significant predictors of car use (Gardner & Abraham, 2008; Donald et al., 2014).

People who did not feel constrained in their mode choice and exhibit pro-environmental beliefs were more likely to use other modes of transport than the car. Likewise, people who positively evaluate the use of public transport, are more willing to use it at the expense of the car (Redman, Friman, Gärling, & Hartig, 2013) and exhibit a higher level of travel satisfaction when using that mode (De Vos, 2019). Perhaps, within this scenario, people who perceive themselves capable of engaging in specific behaviour and show positive attitudes in this regard, live more positively their choice, the time required to act and, ultimately, the value associated with it. On the contrary, value and personal norm did not impact on VOT. As suggested by Khunimhof et al.

(2012), it could be that people prefer maximizing the utility (or minimize the disutility) of travelling instead of prioritizing, for example, the quality of the environment and air pollution. Indeed, in a study on the ecological impact of individual travel behaviour (Hunecke et al., 2007), mobility-related attitudes were better predictors than values.

The results also showed that people tend to give a lower value to their travel time when the general level of service is perceived positively. In general, when it comes to evaluate the quality of services provided, users' perceptions vary in terms of situational circumstances and travel experience (Das & Pandit, 2013; Ramos, Vicente, Passos, Costa, Reis, 2019). In contrast to the classic definition of service level (LOS) used to analyse and assess the standard levels of traffic quality needed to satisfy users, in the present work, the users' perception of the built environment might play a crucial role. In other words, the more a person positively assesses the level of traffic safety, the quality of the infrastructure and the accessibility, the more they will be satisfied with their trip, the higher the likelihood of a lower VOT. It is interesting to note that while relationship between trip satisfaction and VOT have been supported in a previous study (Ambarwati, Indraistuti, & Kusumawardhani, 2017), the LOS standards have rarely been established based on users' perceptions (Das & Pandit, 2013).

Finally, results showed how the length of the trip negatively impact the VOT, that is, the shorter the trip, the higher the value of time travel. It may be plausible to argue that for short distances, people have higher expectations of the time needed to reach their destination. Likewise, short routes may suggest journeys within the city centre where there might be a higher chance of being stuck in traffic or waiting for the bus. In this way, users with unfulfilled expectations may experience a greater sense of frustration than those who are aware in advance of having to travel long distances, which in turn might led to a higher VOT.

Chapter 6. Final Discussion

The dissertation aimed to deepen the role of psychosocial, situational, and infrastructural factors in shaping commuter's modal choice. Specifically, the studies focused on exploring the modal choices of the academic community. As already suggested by Xiao, Liu and Wang (2018), understanding the key determinants of travel behaviours may help in reducing the use of private cars and promoting a modal shift with the chance to develop tailored, integrated and diversified organisational interventions towards sustainable mobility. As a matter of social responsibility and institutional sustainability (Whalen et al., 2013), academic communities will be asked to lead social change in the field of sustainable transportation (Balsas, 2003), to act as advocates and front-runners in developing and improving policies and infrastructure that foster a behavioural change towards sustainable modes of transport (Shannon et al., 2006). Indeed, the academic setting holds a crucial role in reinforcing behaviours and increasing pro-environmental awareness and develop novel habitual mobility patterns, thus providing the opportunity to transfer good organizational practice to the larger community (Zhou, 2012). Commuting behaviour can be considered as a critical area where to concentrate resources. Indeed, in 2014 transport emissions were responsible for 23% of global CO2 emissions (Wang & Zeng, 2018) and our daily choices of mobility are one of the main factors contributing to urban traffic and daily urban CO2 emissions. According to a recent European report (Focas & Christidis, 2017), urban mobility accounts for 40% of all CO2 road transport emissions.

Four studies have been conducted to deepen the understanding of commuter mobility choice, each of them with a specific research question. In the first study, the commuting mode choice has been investigated by exploring the main determinants that could shape the mobility behaviour of students, staff and professors at different commuting distances. Based on the findings,

some variables influence the commuting modal choice of the academic community depending on the short (<5 km), medium (5-30 km) and long distance (>30 km) to be covered have been highlighted. For example, promoting pro-environmental behaviours trough social campaigns might be more effective only for those people who need to cover very short distances. Also, students (or young people) seems to be a sensitive target to focus on, especially in view of their environmental impact on the future when they become older.

Within short and medium distances, organizational actions that help employees in dealing with their family needs could help avoid the use of the car while, at the same time, foster personal and organizational well-being (Page & Nilsson, 2016). Indeed, the presence of children or the responsibility to take care of elderly relatives and people with disabilities predicted people's choice in favour of private car use. Within short trips, adults with family needs prefer to use the car for its flexibility. At the same time, designing awareness-raising campaigns aimed at developing pro-environmental values and norms (and reduce the use of the car) could not be valid if addressed to those who have to deal with long distances (>30km). Actions which include a sustainable mobility plan that provides incentives for those who adopt sustainable means of transport and disincentives for frequent car users (Petrunoff et al., 2015; Yang, Sahlqvist, McMinn, Griffin, & Ogilvie., 2015) are encouraged. Easy access to a shared mobility service might be a reliable alternative strategy to promote for commuters travelling within a limited distance (<30km). The action could prevent the use of the vehicle for a single occupant, thus promoting sustainability and, at the same time, facilitate social support among the academic community.

People who have experienced contextual changes such as a relocation (Walker, et al., 2015) or a residential change (Verplanken & Roy, 2016) can be considered a specific target group to promote a behavioural change and to facilitate the use of a sustainable mode of transport. Within

this "window of opportunity", organisations such as universities could try to develop a strategy to help this target to shift to more sustainable modes of transport for their commuting.

Based on the knowledge and findings gained from the first study, a second related study was set up and conducted with to identify groups of travellers based on their commuting behaviour, comparing segments based on attitudinal, motivational and situational characteristics. Contrary to what has been done in recent years, commuter groups have been defined by their actual mobility behaviour to go to and from work. Indeed, in recent years, researchers have proposed to investigate the underlying motivations, attitudes, perceptions, travel experiences and travel satisfaction to highlight their predictive influence on travel behaviour (Pronello et al., 2011). Researchers have addressed this topic by categorizing the population based on their attitudes towards different modes of transport, their psychosocial travel behaviours factors, perceptions, experiences or travel satisfaction with the aim of identifying some peculiar characteristics on which to base interventions and develop persuasive actions (Anable, 2005; Diana & Mokhtarian, 2009; De Vos, 2018; Pronello & Camusso, 2011; Susilo & Cats, 2014; Ye and Titheridge, 2017). However, as Anable also stated in her renowned article (2005), “the same behaviour can take place for different reasons and that the same attitudes can lead to different behaviours”. The same point is supported by Molin and colleagues (2015) who stressed the possibility of mutual influence between attitudes and behaviours over time.

This made it possible to investigate those factors determining the commuting decision-making process, starting from their final travel behaviour. In other words, the main aim of the study was to explore which factors (environmental, situational, habitual or motivational) can be considered to foster a behavioural shift, bearing in mind the moderating effect of distance as emerged from study 1. The distances thresholds considered routes within the urban centre (less

than 5km), routes from the outskirts (within 30km) to the urban centres and long routes, from one district to another (more than 30km). The two-step cluster analysis yielded a five-segment solution, each one of them with specific characteristics. The “Long-distance commuters”, “Regular bus users”, “Car-dependent”, “Two-wheel urban users” and “Pedestrians” groups were compared based on psychosocial aspects, car use habits, economic and infrastructural aspects, environmental aspects as well as socio-demographic aspects. A classification tree analysis has been conducted to explore the main decision-making determinants, which may encourage the use of the car. For short distances (<5km), the reasons behind the choice of one' s own accommodation appear to be indicative of the type of modal choice that the person will make. Albeit supported by previous studies (Kamruzzaman et al., 2013; Zhou, 2012), the second study went further, investigating how different decisions or motivations involved when choosing the accommodation influence individual modal choice. The modal choice seems to be further oriented by the ease of access to the car or by individual perceived easiness in controlling one's travel behaviour, as well as by individual's habit of using the bicycle regardless of the final destination.

Considering medium and long distances, factors which might affect commuters decision-making process differ, with the PBC that seems to be one of the critical factors in choosing a car. In general, it is well documented the role played by PBC (Abrahamse et al., 2009; Donald et al., 2014), in the present study, age seems to further play a significant role in shaping the decision-making process of commuters. The second study deepens the debate about the tendency of the new generation to prefer the use of greener modes (Delbosc & Currie 2013; Kuhnimhof et al. 2012; Prillwitz & Bar, 2011). Based on our findings, avoiding car use is not primarily motivated by pro-environmental values but rather by low levels of PBC. A poor PBC could be the result of reduced accessibility to the car or a lack of economic resources to buy it. However, as people grow older

(and possibly more willing to pay as a result of working actively, getting married or having children), they might tend to rely more on this transport modality.

Moreover, a trend seems to emerge, especially for those who need to cover long distances. Recently supported by other studies, some road users would seem to be forced to use means of transport that they do not prefer but that at the same time would allow them to reach their destination. In other words, the classic idea of a positive relationship between attitudes and modal behaviour (Beirão & Cabral, 2005; Molin et al., 2016) whereby people with positive attitudes towards a specific mode of transport would choose that modality is not confirmed. Indeed, there is a growing idea which explained the discrepancy between attitude and behaviour, called dissonant travellers, as defined by De Vos (2018). Dissonant travellers choose the mode they seem to like the least when other factors intervene and force them to act in this way. This value-action gap should be the main research focus for future studies. Is the author's belief that it can be a theme offering ground-breaking information on actions to be taken to stimulate a modal shift towards sustainable modes.

The results of the second study increase the theoretical knowledge about commuting modal choice determinants but also provide insights for behaviour change. A neighbourhood with high-quality infrastructure, green areas and a sufficient level of services, seems to incentivize the use of active and sustainable modes of transport. However, an essential condition for ensuring and supporting such a choice is a policy that reduces access to the car (or parking areas). Combining these aspects could be a winning strategy in fostering the adoption of more sustainable modes of transport as already suggested by previous studies (Bueheler et al., 2017; Haustein, Jensen, & Nielsen, 2019). In terms of environmental changes, results from the second study also suggest

focussing on cycle path design that can increase the perceived safety of cycling, such as separated cycling paths or highways.

Regarding car use, instead, it might be practical to increase the costs and difficulties of motorists' travelling. In this sense, actions that would affect the perceived behavioural control of drivers such as limited access to the urban city centre or an increased cost for parking might help "push" those type of travellers in adopting different modes of transport. In this case, however, it would be necessary to improve the quality standards of public transport vehicles, its network connectivity as well campaigns to encourage a positive attitude towards public transport, which is often criticised for not being reliable and comfortable.

Results from the third study are noteworthy because they provide a thicker description of the perceived barriers in mode choices. Based on a qualitative approach, the study has been focused on exploring attitudes, perceptions and motivations of travel behaviour to highlight the reasons behind the modal choice in order to develop more concrete communication strategies and initiatives. Providing discounts or incentives for the purchase of public transport subscriptions, the purchase of e-bikes and the use of shared mobility would seem to be a dominant strategy emerged from this study. In particular, it may positively influence the perception of control over one's modal behaviour. Making a sustainable mode easier to adopt could stimulate people to put their behaviour into practice.

The success of initiatives in reducing personal car use through behavioural change will mostly rely on the ability to persuade the community to use public or active modes of transport, especially for commuting (Van Acker et al., 2016). Some of the possible strategies that the institution can adopt to promote more sustainable travel behaviour are corporate awards for who,

after registering at the corporate competition, proved to travel many miles as possible with sustainable means.

Implications for this study are related to major areas of intervention to reduce barriers in the adoption of public transport such as timing and a lack of an adequate number of routes. In this regard, improving service quality by providing real-time travel information to travellers has been seen to positively reduce scheduling cost (Ettema & Timmermans, 2006), thus making this mode choice more attractive and reliable. Moreover, it is therefore a priority for the stakeholders involved to offer at least a service that allows people to use comfortable, clean and spacious means if the use of this mode should be encouraged. Nonetheless, public transport users who can take advantage of the time available for other activities, whether for work or leisure, declare a higher level of satisfaction and a lower value for their time (Ettema, Friman, Gärling, Olsson, & Fujii, 2012; Line, Jain & Lyons, 211). Another challenging aspect relates to the level of network connectivity from the outskirts to the city centre. While in previous studies users from the suburbs have experienced public transport positively, as a place of socialization (Guiver, 2007), a lack of widespread network able to provide services even to the most remote areas seems to tempt people to prefer the car. Consequently, stakeholders should favour investments in areas outside the city centre.

In addition, the University itself can be on the front side in promoting sustainable mobility and travel behaviour change. Indeed, as already stated in previous research (Bamberg & Schmidt, 2001; Dagiliūtė, Liobikienė e Minelgaitė 2018; Dubuy et al., 2013; Nakayama & Takayama, 2005; Page & Nilsson, 2016), organisational factors may provide the contextual and instrumental basis for the adoption of a more sustainable travel behaviour. Example of loyalty programs or information kits regarding available discounts or routes to be travelled in a sustainable way have

been already tested. From our results, guarded cycling parking facilities or changing rooms facilities might be perceived as powerful actions that might open to an increase in people cycling to work. Another encouraging line of action concern the fit between academic course scheduling and the timetable of public transport. In fact, participants complain about a discrepancy between transport timetables and academic schedules, which forces students to make a choice: to arrive late or leave earlier from the University or, in the worst-case scenario, moving by car.

Furthermore, parking management policies aimed at reducing car slots availability nearby the University could be another effective strategy to discourage the use of car for home-work trips. However, an essential aspect when choosing the private vehicle is the presence of children or family obligations that require the person a certain degree of flexibility and speed in travel. This aspect, further supported by results from both the first and the second study, should be further investigated since it seems a personal constrains without a reasonable and adequate response, both from an organisational as well as policymaking making level. Among additional interventions, providing discounts, incentives or support in terms of accommodation is another interesting line of action that emerged from this study that could facilitate the adoption of sustainable modes of transport.

Finally, results from the fourth study offer expanded knowledge on the value of time and its relations with psychosocial aspects. As already mentioned, the value of time (VOT) has received key attention because it constitutes a measure to justify investment in transport schemes, both as a reliable driver to develop infrastructure for car traffic as well as to incentivize the use of sustainable transport modes. Accordingly, results can provide inputs to develop interventions which should more focused on increasing users' satisfaction. Some specific components of the trip, such as safety, the quality of infrastructure and level of accessibility emerged as key areas

where to focus on. Moreover, results are relevant for policymakers such as local governments, urban planners, road authorities, traffic regime managers, i.e. those who should make decisions on traffic management and mobility-related demands, considering that the higher the propensity to use means with a low index of unsustainability, the lower the value associated with time.

Based on the latest research developments, a multidisciplinary approach seems to be essential. The results from the fourth study highlighted the importance of addressing users' perceptions and their commuting mode choice, which differently affect one own's value of time. As time is a critical decision-making factor in the modal choice, transport policy should focus on adopting a different course of action in relation to the different types of commuters highlighted so far. Indeed, from our results, travellers on long distances perceive a lower level of value of time in case the overall quality of the public transport reach the adequate standard in terms of comfort, reliability and cleanness. For those travellers within short distances, a high-quality infrastructure neighbourhood with limited access to cars and reduced congestion seems the proper actions to take in order to reduce travellers' VOT. Apart from the target of interest, an economic paradigm (i.e. VOT) that is also based on individual, motivational and attitudinal influences seem necessary. In other words, when people adopt a sustainable mode of transport with inadequate service and infrastructures (or perceived as such), they tend to overestimate their actual travel time (i.e. over-perception), thus attributing higher monetary values. Specifically, this pattern seems to be particularly pronounced among those who travel more frequently (i.e. commuters). Accordingly, interventions aiming at facilitating access to public transport, increasing frequency of service to reduce waiting time (which is the leading cause of over-perception) and decreasing the relative advantages associated with the use of private vehicles (Gonzalez, Martínez-Budría, Díaz-Hernández, & Esquivel, 2015) are strongly encouraged.

In the near future, innovative interventions to promote sustainable mobility or to support travel demands will be needed to address climate change and decarbonisation. An expanded knowledge on psychological and social factors will help the decision-makers to design innovative and effective actions As experts in this field have pointed out, a traffic management system, even if technically perfect, could not reach satisfactory standards if it is not esteemed based on users' perceptions, motivations, travel behaviour reasons and preferences (Das & Pandit, 2013). In line with this perspective, this thesis contributed to understand the role of behavioural and psychosocial factors in mode choices and travel behaviours.

In the face of such a complex scenario, the new guidelines dictated by the European Community in promoting a substantial change in terms of modal behaviour looked very stimulating. Many European cities and regions areas are committed to develop into zero-emission areas. New technologies and innovative measures are emerging, but they are not taken up at a scale that is necessary to meet our climate targets and European transport policy objectives. Europe's urban areas are struggling to develop themselves into well- connected multimodal and multi-usage nodes for smart and clean mobility. Apart from the introduction of new technologies capable of making vehicles less and less polluting (e.g., electric vehicles), an interesting line of action concerns technological innovation regarding the design of public transport, highly-connected and smart infrastructures as well private ecological vehicles. As also suggested in the literature, the possibility of using comfortable spaces in which to carry out other useful activities, also in the light of the present results, seems to be a stimulating line of action in encouraging people to use this means of transport, where the younger generations can actively embrace and promote a sustainable modal revolution.

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Appendix

The following table is a schematic presentation of the steps by which the researchers proceeded from codes to labels, from labels to categories and from categories to core themes. The list is divided into categories (*axial coding*), in turn composed of labels and codes (*open coding*) that link to the central themes (*selective coding*).

Table 11. Overarching categories showing the underlying constructs linking barriers and triggers factors influencing mode choice

Categories	Labels	number of Codes	Core themes
Role of local and regional political authorities	Synergies between relevant actors	18	Environmental and organisational factors
	Downtown stop car	12	
	Civic education, risk perception campaigns	7	Perceived barriers in cycling and walking
Benefits and discounts	Information on benefits and discounts	16	Perceived barriers in the use of public transport
	Discounts or advantages for integrated transport	15	
	Discounts or advantages for railway services	22	
	Discounts or advantages for bus services	38	
	Discounts or advantages for airplane routes 4	4	
	Discounts or advantages for monthly, weekly season tickets or single route	14	
	Discounts or advantages for fellowship, PhD students	23	
Non-resident academic population	Non-resident population or long-distance commuters' issues	53	Environmental and organisational factors
Public transport system	Comfort and quality of bus vehicles	28	Perceived barriers in the use of public transport
	Punctuality and effectiveness of bus service	44	
	Upgrading of bus lines	41	
	Bus at night	8	

	Ad-hoc shuttles/stops	21	
	Railway services	26	
	Public transport to Terracini area	32	
	Public transport to Beverara area	30	
	Public transport to Ozzano	19	
	Public transport to Ravenna	17	
	Public transport to Fanin area	24	
Role of the university	Hours lessons and exams	21	Environmental and organisational factors
	Multi-campus movements	11	
	Organisational bottom-up strategies	13	
	Sustainability at unibo	28	
	Incentives and strategies by the university	11	
	Telework/telelections	8	
Bicycle use	Bicycle parkings issues and theft	42	Perceived barriers in cycling and walking
	Cycling infrastructure	61	
	Other issues on cycling	6	
	Incentives to use electric bicycles	17	
	Bicycle and public transport synergy actions	5	
Sharing mobility	Bike sharing	21	Environmental and organisational factors
	Car sharing	14	
Car use	Attitudes towards car use	10	Perceived constraints in the adoption of alternatives to car use
	Private car use compared to public transport inefficiency	74	
	Car use for personal reasons	27	
	Car parking issues	54	
Housing issues,	Reasons for the accommodation	34	Environmental and organisational factors

Massive thanks to Prof. de Waard and Prof. Pietrantoni who made this experience so challenging, rewarding and at the same time so enjoyable!

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