Utrecht University

Cyclists are the happiest commuters: What about e-bikers?

A master's thesis about the differences in commute satisfaction between regular cyclists and e-bikers

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Preface

In front of you lies my master’s thesis ‘Cyclists are the happiest commuters: What about e-bikers?’ With this thesis, I will finish my one-year Human Geography master with the chosen track Daily Life & Public Space, at the Utrecht University. Within this master’s thesis, research has been done on commuter satisfaction for e-bikers affiliated with the Utrecht University. I gained knowledge about the concept of trip satisfaction and in particular commuter trip satisfaction. My knowledge about the differences between regular cyclists and e-bikers has also increased. Finally, I have also become proficient with quantitative data research, in particular with SPSS.

This thesis has been written in the period from March 2023 to the end of June 2023. I look back on this period as an educational but also busy period. This makes it a relief moment for me that I have been looking forward to for some time. Graduating is therefore the last step that people look forward to during their master's. With this thesis, I hope to transfer my gained knowledge and information to the scientific community.

For the writing of this thesis, I want to thank my supervisor prof. dr. ir. Dick Ettema for helping me with useful information and feedback and getting helpful insights into the often hard theories around commuter trip satisfaction. I deliberately chose not to do an internship because of the many internships I have already done during my bachelor. Thanks to my supervisor, I was still able to use a mobility survey that is held at the university every year. This saved me a lot of time in collecting the data needed for this research.

I am happy with this last step of my entire study career. After this it is time for the next step in life: my work career. Hopefully you enjoy reading this report!

Ruben Frederik

Utrecht, June 2023

Abstract

This thesis investigates whether there is a difference in trip satisfaction between regular cyclists and e-bikers. The electric bicycle (e-bike) has experienced a rapid increase in the last years (Plazier et al., 2017). In the Netherlands, 40% of the sold bicycles were e-bikes in 2018 (de Haas et al., 2022). It is widely studied and concluded that commuters who cycle are the most satisfied with their trip. There are multiple reasons why this group is the most satisfied. There has been a lot of research on the e-bike, but it isn't clear what the position of the e-bike is in the list of happiest commuters. Especially in contrast to the regular bicycle. It is important to understand these levels of satisfaction between the two types of bicycles because it can help to encourage the use of the e-bike over the use of the car (St-Louis et al., 2014). It is also important to get to know the advantages of e-biking to get to know the mental health advantages, rather than only the physical health advantages. The research question that is answered in this thesis is: "Do e-bike users have a higher trip satisfaction on their ride to and from the different locations of the Utrecht University compared to regular bicycle users?"

Data from the three-yearly mobility survey that was held at the Utrecht University (UU) has been made available for this research. This survey provides a detailed view on mobility opinions and commuting habits of a lot of students, PhD students, and staff members. The satisfaction with Travel Scale (STS) by Ettema et al. (2011) was used to gauge participants' satisfaction with their commutes. The STS consists of nine different items that respondents could answer with a rating between -4 and 4. These nine items are then grouped into three new scales: positive deactivation, positive activation, and cognitive evaluation. Each respondent's satisfaction with travel scores were created by averaging their responses to each of the three subscales. After that, each respondent's individual satisfaction with travel score was created by averaging their responses to all nine items into the new dependent variable STS total. This means that there have been created four multiple linear regression models. The statistics program SPSS was used for these analyses.

In three of the four different regression models, the change in R-square is very small when the variable 'mode' is added. This means that mode choice (riding a regular bicycle or an e-bike) doesn't have a significant influence on the commuter trip satisfaction (STS score). Only in the cognitive evaluation the independent variable 'mode' is significant. In this model it means that the regular bicycle group experiences their commute as less easy and less comfortable than the e-biker group. Control variable 'age' seems to have an influence on trip satisfaction in all four models. It seems that the older the people are, the higher the trip satisfaction. The answer to the research question sounds as follows: "E-bikers only experience a significant higher trip satisfaction than regular cyclists in the cognitive evaluation model. This means that e-bikers are more satisfied in terms of easy use and comfort. In the other three models, there doesn't seem to be a significant difference between the two groups."

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1. Introduction

This first chapter of this thesis introduces the topic. The first part explains the problem and the topic itself (1.1). Then, the topic will be narrowed down in the focus and scope (1.2). The societal and academic relevance are written out in the next paragraph (1.3/1.4). And finally, the research aim and research questions are drawn up (1.5).

1.1 Introduction to the topic

The positive effects of cycling as an alternative to the car on health and the environment are well established in the scientific literature (Andersen et al., 2000; Bauman & Rissel, 2009; Fishman & Cherry, 2016). The electric bicycle (e-bike) has experienced a rapid increase in the last years (Plazier et al., 2017). In the Netherlands, 40% of the sold bicycles were e-bikes in 2018 (de Haas et al., 2022). Formerly, elderly people were using the e-bike the most in the Netherlands, while there now is a trend towards the adoption under younger age groups as well (de Haas et al., 2022). E-bike adoption can lead to a substitution of motorized commuting (MacArthur et al., 2018) as well as a substitution of commuting by regular bicycle (Jones et al., 2016a; Kroesen, 2017). However, these studies show a replacement of both regular bicycle use as well as car use.

It is widely studied and concluded that commuters who cycle are the most satisfied with their trip (Chatterjee et al., 2020; Handy & Thigpen, 2019; Humagain & Singleton, 2020; St-Louis et al., 2014; Wild & Woodward, 2019). Subjective wellbeing can be affected by the commute over three time horizons (Chatterjee et al., 2020). These are: (1) during the journey, (2) immediately after the journey, (3) over the longer term. Because commuting has an effect on longer periods, it is important to stimulate commuting by bicycle. One study found out why cyclists are the commuters with the highest trip satisfaction (Wild & Woodward, 2019): (1) cyclists have a high degree of control and arrival-time reliability, (2) cyclists have enjoyable levels of sensory stimulation, (3) cyclists experience the happy effect after exercise, (4) cyclists have better opportunities for social interaction.

However, it isn’t clear what the position of the e-bike is in the list of happiest commuters. Especially in contrast to the regular bicycle. There has been a study on the change in level of satisfaction for car users who switched to e-bike use (de Kruijf et al., 2019). This study found that overall trip satisfaction is higher for e-bike users than for car users. Still, this study doesn’t show the difference in satisfaction between regular bicycle users and e-bike users. A study from Belgium showed that people using an e- bike are more satisfied with their trip than people using a regular bicycle (Nematchoua et al., 2020). However, they based this on a Net Promoter Score (NPS) and only 14 respondents in their survey used an e-bike. In other words, they based their results on people who would recommend travelling by e-bike to others, rather than their actual experiences with e-bikes. They also acknowledge this in their limitations. It is important to understand these levels of satisfaction between the two types of bicycles because it can help to encourage the use of the e-bike over the use of the car (St-Louis et al., 2014). It is also important to get to know the advantages of e-biking in order to get to know the mental health advantages, rather than only the physical health advantages. Furthermore, it is important to get to know what groups to target when e-bike use will be encouraged in the future. This because a modal shift from car to e-bike is more important than a shift from regular bicycle to e- bike.

1.2 Focus and scope

This research focusses on employees and students of the Utrecht University in the Dutch city of Utrecht. Therefore, the research area mostly consists of people living in and around Utrecht. The survey that is used in this research is held in the beginning of 2023. This means that the time period of the research is very recent. Because the survey is held with respondents from the Utrecht University, the study group mainly consist of higher educated people. But this is further emphasized in paragraph 3.2. The theme that this research focusses on is trip satisfaction and in particular commuter trip satisfaction. In the scientific literature, this theme often focusses on multiple life domains and time zones in someone's life. However, the scope of this research is focussed only on the time zone 'during the trip'. When it comes to type of e-bikes, all possible e-bikes are taken into account (for an overview see sub paragraph 2.1.1) except for the speed pedelec because this type has a different legal status in the Netherlands as well as a higher maximum speed.

1.3 Societal relevance

This research has a societal relevance because of multiple reasons.

Promoting forms of transportation that lower carbon emissions is essential in light of growing worries about *climate change and environmental sustainability*. Policymakers and urban planners can establish strategies to promote sustainable commuting practices, therefore lowering dependency on (fossil fuel-based) cars, by understanding the elements impacting commuter trip satisfaction for regular cyclists and e-bikers.

Cycling has numerous *health advantages*, including increased cardiovascular fitness, lowered risk of chronic diseases, and improved mental well-being. By understanding the differences in trip satisfaction between the two different forms of cycling, public health programs and urban planning interventions can be informed.

Discussions on *transportation equity* can also benefit from examining the differences in commuter trip satisfaction between regular cyclists and e-bikers. E-bikes offer the potential to provide riding accessibility for a larger population, including those who might experience physical restrictions or lengthier commutes. In order to discover potential advantages or disadvantages in the adoption of e-bikes as a mode of transportation, it can be helpful to understand the satisfaction levels of e-bikers in comparison to regular cyclists. This information can then be used to guide policies intended to promote inclusive and equitable transportation systems.

In conclusion, by addressing sustainability, health, and transportation fairness, this research on the differences in commuter trip satisfaction between regular cyclists and e-bikers has significant societal value. The research can contribute to broader discourses on transportation and societal well-being while informing policies, interventions, and technologies that support sustainable and pleasurable commuting options.

1.4 Academic relevance

As mentioned before, it is widely studied and concluded that commuters who cycle are the most satisfied with their trip (Chatterjee et al., 2020; Handy & Thigpen, 2019; Humagain & Singleton, 2020; St-Louis et al., 2014; Wild & Woodward, 2019). Probably because of the relatively recent rise of the e-bike, there hasn't been done research on the position of the e-bike in the list of modes with the happiest commuters. Especially in contrast to the regular bicycle. There has been a study on the change in level of satisfaction for car users who switched to e-bike use (de Kruijf et al., 2019). However, this study does not provide information on the differences in satisfaction between regular bicycle users and e-bike users. Another study from Belgium conducted by Nematchoua et al. (2020) reported that e-bike users were more satisfied with their trips than regular bicycle users. However, this conclusion was based on a Net Promoter Score (NPS) and only 14 respondents in their survey used e-bikes. This means that their results were derived from individuals' likelihood to recommend e-bike travel rather than their actual experiences with e-bikes.

This research tries to fill in this research gap by looking at the specific differences in commuter trip satisfaction between regular cyclists and e-bikers. The research findings can also inform theories, contribute to academic discourse, and potentially influence policy decisions and interventions in various academic fields and interdisciplinary areas.

1.5 Research aim and research questions

The aim of this research is to fill a knowledge gap in the existing literature. This gap contains the difference in commuter trip satisfaction between regular cyclists and e-bikers. In other words: what group rates their commute the highest? This is done by looking at multiple dimensions of trip satisfaction. Having an insight in this can have many advantages as mentioned in paragraph 1.3 and 1.4. This research elaborates on the existing knowledge on differences in commuter trip satisfaction between other modes, which is frequently studied.

In order to fulfil this aim, the following research question is drafted:

"Do e-bike users have a higher trip satisfaction on their ride to and from the different locations of the Utrecht University compared to regular bicycle users?"

The following sub questions are drafted to answer the research question above:

1. What elements contribute to the experience of the commute for e-bikers and is there a difference between regular cyclists?
2. What are the differences in characteristics between e-bikers and regular cyclists?
3. What is the role of distance in commute satisfaction between e-bikers and regular cyclists?

Sub question 1 will be answered in chapter 2 (Literature review) by examining scientific literature. The second sub question will be answered in chapter 2 as well. Finally, sub question 3 will be answered in chapter 4 (Results). This question is asked in this research because of the potential that the e-bike has in getting more people on bikes. This is because e-bikes can travel longer distances without having to put too much physical effort in cycling.

2. Literature review

This chapter consists of two parts. The first part (2.1) focusses on broader literature around e-bikes. The second part (2.2) focusses only on scientific literature around the concept of (commuter) trip satisfaction. The chapter concludes with the conceptual model (2.3) that is used in this thesis.

2.1 Literature on e-bikes

This paragraph first shows all types of e-bikes that are available in the Netherlands. It then shows some numbers and facts about e-bike use in the Netherlands. The chapter concludes with the potential that the e-bike has on multiple aspects.

2.1.1 Types of e-bikes

There are a lot of e-bikes on the Dutch market. This sub paragraph sums up the most popular e-bikes and their advantages and disadvantages (*ANWB*, n.d.).

- Electric mom bike/family bike:
  Is perfect for transporting the kids to and from the day-care. It features a wider instep in addition to a lower one. For a front seat, more room has already been built into the frame. The rear carrier is frequently also significantly enlarged so that you can carry more stuff in addition to a seat.
- Speed pedelec/speedbike:
  The speed pedelec isn't restricted to 25 km/h, unlike practically all other electric versions in the Netherlands. With the speed pedelec, 40–45 km/h can be attained. The bike is quite stable and was made for those greater speeds. Additionally, it has an engine that is capable of producing a lot of power. These motorcycles have a helmet requirement. Since a speed pedelec also has a license plate, insurance coverage is required. Those who already hold a B driving license (in the Netherlands, for a car) are exempt from taking a special test. You must first obtain an AM driving license (moped) if you don't already have one.
- Electric cargo bike:
  This electric cargo bike is very popular in the Netherlands. It is available in two- and three-wheel variations. It can be used for parents to transport their children, or it can be used for distributing cargo. There are limitations to the electric cargo bike. On this bicycle more than any other, steering dexterity is needed, as well as the discipline to constantly monitor the traffic. The powered cargo bike takes up a lot of room on the cycle path, just like its standard non-powered counterpart.
- Electric city bike:
  Not all bicycles that are used in cities are considered city bicycles. City bikes are frequently more sober than the electric mom bike/family bike. The most crucial aspect is that you can sit upright on it, and the handlebars and saddle distance may be changed to accommodate this. This gives a clear picture of the often-hectic city traffic. In this manner, you can closely monitor everything. A reliable luggage carrier is typically included with the electric city bike, making it simple to transport goods. It

often has an automatic gear system with typically only three to five gears. Popular examples of this type in the Netherlands are VanMoof, Cowboy, and Veloretti.

- Electrical fatbike:
  The best effort made by the industry to encourage young people to purchase e-bikes was to create an electric model that you also wanted to appear to be using as a young person. Typically, it has the appearance of a sturdy moped or motorcycle and is appropriate for shorter trips.

All e-bikes listed above are taken into account in this research. Except for the speed pedelec because this type has a different legal status in the Netherlands as well as a different speed. The next sub paragraph shows the numbers behind the e-bike.

2.1.2 Facts and numbers

The popularity of electric bicycles (e-bikes) has grown recently. Even while the average age of e-bike owners is still rather high, younger people are starting to favour them more and more (de Haas & Hueng, 2022). The 'Knowledge Institute Mobility' (KIM), part of the Dutch 'Ministry of Infrastructure and Water management', published a report about the purchase and use of the e-bike in 2022 (de Haas & Hueng, 2022). This report is mainly used in this subparagraph because it describes the situation in the Netherlands the best. However research by Jones et al. (2016) in the Netherlands and the UK show similar results to the KIM study when it comes to the motivations and barriers as described below. Two articles by Simsekoglu & Klöckner (2019a, 2019b) in Norway also show similar results.

Motivations and barriers for purchase (de Haas & Hueng, 2022)

The ability to move more quickly and efficiently seems to be by far the most significant factor for persons who already own an e-bike. The following three explanations are all connected to health. Nearly 40% of e-bike users purchased the vehicle because they thought it would improve their physical well-being. Nearly 28% of owners cited the e-bike's benefit to mental health as a factor in their decision to buy. Finally, 25% of the e-bike owners say that they either do not or can only use a regular bicycle to a limited extent due to their physical health. Of the latter group, more than half (52%) and four in ten (43%) would cycle less frequently without an e-bike, respectively. Only 5% would exhibit the same mobility on a bicycle. Despite physical constraints, the e-bike provides an option for active transportation for a sizable portion of the Dutch population.

The largest barrier, it would seem, is the cost of the e-bike. The price is a concern for the purchase for roughly 40% of the owners. 61% of non-owners with plans to purchase an electric bicycle said they haven't done so yet due to the cost. The fact that the regular bicycle has not yet reached the end of its useful life (38%) and the belief that riding a regular bicycle is healthier (37%), are the following two reasons why people haven't (yet) bought an e-bike. The fear of theft also seems to prevent people from making purchases. This is a deterrent to buying an electric bicycle for almost a quarter (23%) of owners and roughly 19% of intending non-owners. The battery's life is the following. 20% of owners and 16% of non-owners had this motive, respectively.

Future

Dutch workers commute an average of 9.5 km on e-bikes to and from work and find this distance acceptable. The majority of trips that the Dutch people take each year are within a reasonable distance. For instance, 58% of commuter trips are manageable with an e-bike. About 30% of those trips involve driving a car. There is still potential to encourage the usage of electric bicycles, and there may be additional factors preventing people from purchasing them.

It is expected that e-bike ownership will rise in the next years and that usage will follow. The KIM expects that over the course of five years, from 2019 to 2024, the use of e-bikes will increase by roughly 45–70% as a result of the rise in e-bike ownership. A portion of that expansion comes at the price of regular bicycle use. Due to a rise in e-bike ownership, the overall distance travelled by bicycle increases to be predicted by 6% to 8%. The COVID-19 pandemic and other influencing factors, as well as demographic and economic changes, are not taken into account in the study by the KIM.

Figure 2.1 shows the impact of the anticipated e-bike ownership growth on the mode split by distance class. The blue line is the e-bike, grey the bus/tram/metro, light blue the personal car, orange the regular bicycle, yellow the train, and green the car as passenger. The continuous line per colour shows the use in 2018/2019. The broken line shows the optimistic scenario for 2024. Finally, the dotted line shows the pessimistic scenario for 2024. As can be seen in the figure, e-bike use will increase in both scenarios, while regular bicycle use will decrease in both scenarios. Another aspect that the figure makes clear, is that e-bike use stays more stable over the distance classes. For regular cyclists the use drops very fast after the distance class of 2 kilometres.

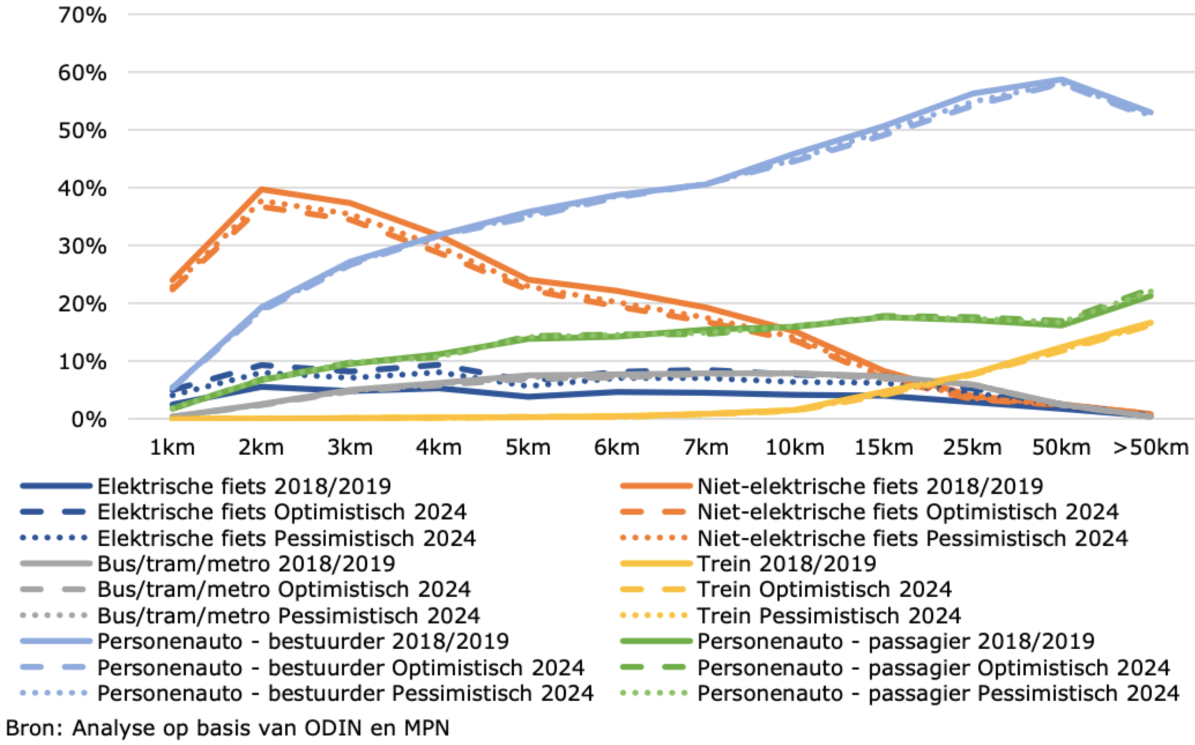

Figure 2.1 Impact of anticipated e-bike ownership growth on the mode split by distance class (de Haas & Hueng, 2022)

2.1.3 Potential of e-bikes

As described above and what can be seen in figure 2.1, e-bikes have the potential to let people travel longer distances without needing a car. This is also discussed in other research papers (de Haas et al., 2022; Engelmoer, 2012; Liu & Suzuki, 2019). This potential is not always likely to be fully used because most people are likely to substitute the regular bicycle (de Haas et al., 2022). But still, e-bike use is always reducing CO2 emissions when it substitutes a fossil fuel powered car. It also has the potential to give people with limited ability and mobility more freedom to move around (MacArthur et al., 2018; McQueen et al., 2020). All of this makes e-bikes a promising alternative means of transport.

2.2 Trip satisfaction

A greater trend in the area of transportation toward the study of travel behaviour may be seen in the increased focus recently placed on trip satisfaction as a crucial step in the promotion of sustainable forms of transportation (St-Louis et al., 2014). Theories of transport geography and social psychology have increasingly been linked. For instance, Van Acker et al. (2010) made it obvious that individual opportunities and constraints, which are nested in social and physical surroundings that carry their own set of opportunities and constraints, have an impact on travel decisions and perceptions. So, both internal (social psychology) and external (transport geography) influences might have an impact on a person's travel behaviour. While traditional transport geography theory (activity-based, built environment) is the source of the attention given to external factors in travel behaviour studies, the additional inclusion of internal variables, such as sociodemographics, personality, attitudes, preferences, and habits, results from the incorporation of social psychology theories (Van Acker et al., 2010). Figure 2.2 shows how these internal and external factors are linked with trip satisfaction according to St-Louis et al. (2014).

There have been many studies on the relationship between trip satisfaction and its determinants (Ettema et al., 2016; Maheshwari et al., 2022). It appears that commuting is usually seen as an activity that is not enjoyable (Kahneman et al., 2004). This is due to a list of determinants like the built environment, subjective and socio-demographic characteristics, and trip characteristics. This last determinant appears to have an important effect on how satisfied people are with their commute. As mentioned earlier, multiple studies show that people who use active modes for their commute are more satisfied with their trip than people who use a car or public transport (Ettema et al., 2016). Factors like physical activity, interaction with the environment, and the degree of control over the trip partially explain this difference between the modes.

In this paragraph, the different factors that influence the trip satisfaction will be explored, split up into internal factors and external factors.

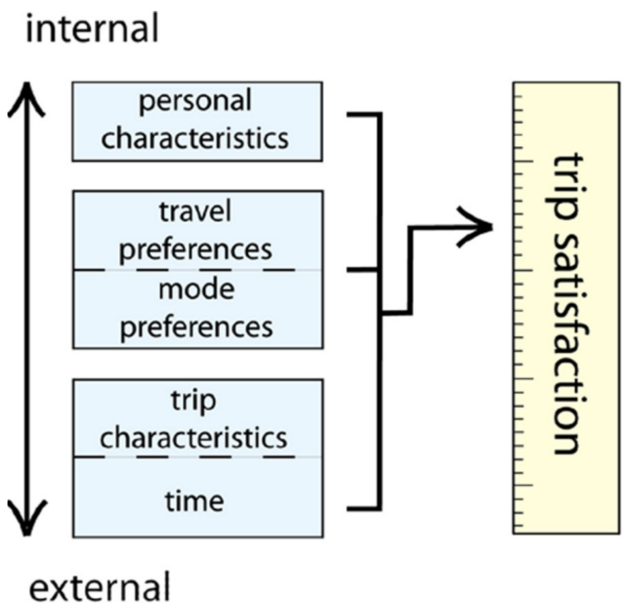

Figure 2.2 Internal and external factors that affect trip satisfaction (St-Louis et al., 2014)

2.2.1 Trip satisfaction affecting other life domains

In this sub paragraph a distinction will be made between ‘trip satisfaction’ and ‘satisfaction with daily travel’ according to a paper by De Vos & Witlox (2017). Trip satisfaction contains the experienced emotions and people’s mood during a trip. Satisfaction with daily travel refers to how satisfied people are with their patterns of daily travel. Subjective well-being is often regarded as an important part of trip satisfaction (Ettema et al., 2011). First it is important to understand the basics of subjective well-being. Diener et al. (1999) concludes that subjective well-being consists of four elements, namely (1) presence of positive feelings, (2) absence of negative feelings, (3) domain satisfaction, (4) overall life satisfaction. Number 1 and 2 can be seen as the mood of a person at that moment. Number 3 can be seen as satisfaction on a medium-term within a specific domain of someone’s life. Finally, number 4 can be seen as how good someone’s life is over a longer term. When we take the distinction between trip satisfaction and satisfaction with daily travel by De Vos & Witlox (2017), trip satisfaction can be seen as the short-term subjective well-being (1 and 2). Satisfaction with daily travel can be seen as a medium-term domain satisfaction (3). But this medium-term domain satisfaction has an influence on the long-term life satisfaction (Schimmack, 2008). Subjective wellbeing can be affected by the commute over three time horizons (Chatterjee et al., 2020). These are: (1) during the journey, (2) immediately after the journey, (3) over the longer term.

Subjective well-being has two dimensions, according to Diener et al. (1985): cognitive and affective well-being. An individual's evaluation of his or her life in general, mostly based on their objective life circumstances, is referred to as *cognitive well-being*. Instead of explicitly expressing someone’s feelings or mood, it is a rating of how well someone’s life is going. Existing tools, such as the satisfaction with life scale (SWLS) (Diener et al., 1985) or a single item scale, are used to assess cognitive well-being (Allen et al., 2022). The term *affective well-being* describes a person's emotional state. It can be assessed through quick self-reports of mood or feelings while engaging in an activity or traveling. Alternatively, affective well-being may be measured retrospectively. The Swedish Core Affect Scale (SCAS) is a possible tool to assess emotional wellbeing (Västfjäll et al., 2002). This approach makes the assumption that emotions may be broken down into two fundamental dimensions: activation (versus de-activation) and valence (positive versus negative). In contrast to *de-activation*, which is a state associated with the absence of such stimulus, *activation* describes how much an individual is aroused by stimuli from their surroundings. The "affect grid" can be used to determine an individual's emotional state based on their scores on both dimensions (Ettema et al., 2013). They have illustrated this which is seen in figure 2.3. For example, "enthusiasm" is a high-valence, activated emotion, whereas "relaxation" is a high-valence, de-activated feeling. As seen in figure 2.3, this produces two dimensions oblique to valence and activation, indicating (1) how much someone feels positively activated (for example, enthusiastic) instead of negatively de-activated (for example, bored), and (2) how much they feel positively de-activated (for example, relaxed) instead of negatively activated (e.g., stressed). It should be emphasized that assessments of affective well-being may be made for temporal periods including the present moment, days, weeks, or months. When affective states span several days, they are typically referred to as moods (Ettema et al., 2013). Paragraph 2.2.6 will build further on this model.

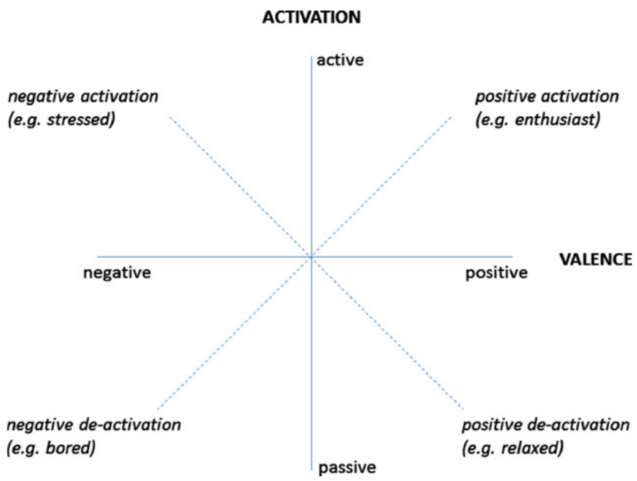

Figure 2.3 Dimensions in the Swedish Core Affect Scale (SCAS) (Västfjäll et al., 2002)

So, trip satisfaction can influence multiple stages in the overall life satisfaction. However, there is a bidirectional relationship between trip satisfaction and life satisfaction (De Vos & Witlox, 2017). According to the authors there is evidence that people with a higher life satisfaction will also experience a higher trip satisfaction. Figure 2.4 shows this bidirectional relationship over the three terms applied to commuting.

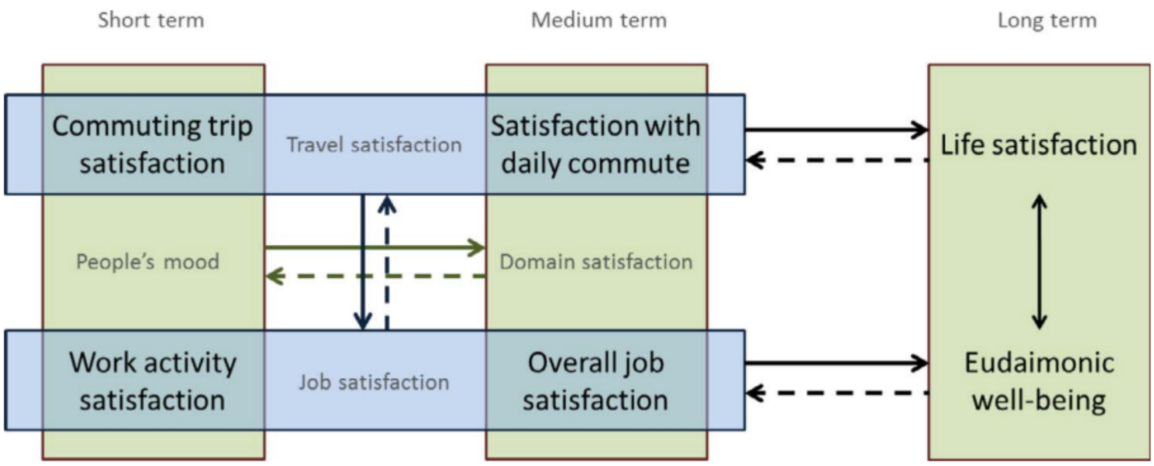

Figure 2.4 The link between travel satisfaction and long-term well-being applied to commuting (De Vos & Witlox, 2017)

There is a debate on how much the trip satisfaction accounts for the overall satisfaction. Activities outside of the home have a great influence on the subjective well-being (Abou-Zeid & Ben-Akiva, 2012). This can make the trip feel more positive because of knowing that someone is going somewhere nice. A trip in itself can also increase satisfaction through things like speed or exposure to environment (Mokhtarian et al., 2015).

2.2.2 Trip satisfaction by mode

This sub paragraph will provide a better understanding of how other mode users generally experience their trip.

For the *private car*, instrumental factors are found to be a great motive for the use of this vehicle (C. J. Bergstad et al., 2011; Steg, 2005). The private car enables simple access to routine, out-of-home activities that have been demonstrated to be significant for subjective well-being, such as work, involvement in children's activities, dining out, and shopping (C. J. Bergstad et al., 2012). But not only instrumental factors are an important motive. Factors like joy, prestige, freedom, and independence also play a role. These factors are more emotionally connected to driving a car (C. J. Bergstad et al., 2011; Steg, 2005). Privacy, security, and relaxation are also important factors (Gatersleben, 2014; Jain & Lyons, 2008). However, it is possible that drivers experience stress because of long commutes and congested traffic. This stress can even be taken into the workplace (Novaco et al., 1989). A negative emotion like boredom is a possible feeling that a car commute can evoke in the case of delays and waiting times (Gatersleben & Uzzell, 2007). Multiple studies have showed that people who commute by car are less satisfied with their trip than people who use an active mode (walking or cycling) (Martin et al., 2014; Olsson et al., 2013). These same studies state that despite the fact that car users may be fully aware of the negative emotions listed above, they occasionally are not aware of the potential detrimental effects on the environment and their own subjective well-being.

The use of *public transportation* can have many advantages. The fact that it encourages an active and healthy lifestyle and the fact that it is soothing and less stressful than driving a car can all be used to explain why people can be satisfied with public transportation (Redman et al., 2013). Those who use public transportation can participate in a variety of fun activities while riding rather than fighting traffic. Also, it has been proposed that excellent public transportation encourages social connection and involvement in enjoyable activities, both of which are crucial for a person's subjective well-being (Cao, 2013; Ettema et al., 2010). Improvements and increased integration between public transportation and active transportation (walking and cycling) would probably have positive effects on subjective well-being and help make cities more liveable. However, a high service quality, reliability, low fare prices, a high frequency, and speed are needed to provide these benefits, and this is not everywhere the case (Redman et al., 2013).

Users of *active modes* of transport for their commute are more satisfied with their trip than people who commute by a car or public transportation (Martin et al., 2014; Olsson et al., 2013). Many factors contribute to this. One factor is the opportunity to enjoy the surroundings because people move on a speed that is human scaled (Gatersleben & Uzzell, 2007). As a result, people who use active modes experience their trip as more relaxing, exiting, pleasant, and interesting. Active modes are also appealing because they produce the best amount of arousal. Driving a car is rated as stressful, while taking public transportation is rated as monotonous, whereas cycling and walking are rated as thrilling and enjoyable. Physical activity is another reason for the high trip satisfaction among active mode users (Ekkekakis et al., 2008). However, the authors note that this level depends on the physical condition of a person. The high trip satisfaction of walking can be contributed to factors like social interaction, autonomy, independence, closer social ties, and neighbourhood cohesion and trust (du Toit et al., 2007; Ettema & Smajic, 2015; Ziegler & Schwanen, 2011).

Personal and environmental factors also play a role in trip satisfaction for active modes of transport. Trip distances, mixed land use, network layout, quality and safety of the infrastructure, and weather (less wind and less rain) are examples of factors that stimulate cycling and add to a higher trip satisfaction (Heinen et al., 2010).

The levels of trip satisfaction between the three main groups of modes (private car, public transportation, and active modes) are well established in the literature. However, it isn’t clear what the position of the *e-bike* is in the list of most satisfied commuters. Especially in contrast to the regular bicycle. There has been a study on the change in level of satisfaction for car users who switched to e-bike use (de Kruijf et al., 2019). This study found that overall trip satisfaction is higher for e-bike users than for car users. Still, this study doesn’t show the difference in satisfaction between regular bicycle users and e-bike users. A study from Belgium showed that people using an e- bike are more satisfied with their trip than people using a regular bicycle (Nematchoua et al., 2020). However, they based this on a Net Promoter Score (NPS) and only 14 respondents in their survey used an e-bike. So, they based their results on people who would recommend travelling by e-bike to others, rather than their actual experiences with e-bikes. They also acknowledge this in their limitations.

The exact factors that influence trip satisfaction for e-bikers and regular cyclists will be further explored in the sub paragraphs following.

2.2.3 Internal factors influencing trip satisfaction

The internal factors mostly contain of personal preferences, expectations, and attitudes. Personal preferences and expectations of the cyclists themselves can influence trip satisfaction (St-Louis et al., 2014). Ory & Mokhtarian (2005) discovered that the values and lifestyles of travellers were crucial in explaining satisfaction for both short and long commutes. For instance, a major explanatory variable for happiness with short commutes for active modes was having a pro-environmental attitude. They found some new factors that influence travel satisfaction like curiosity. Additional tasks that can be carried out while traveling, like the exercise that you get while cycling, can make a trip be better perceived (St-Louis et al., 2014).

When it comes to attitudes, Ye & Titheridge (2017) found that attitudinal variables were found to have a stronger association with travel satisfaction compared to socio-demographics and the built environment. Positive attitudes towards cars, public transit, and walking were all linked to higher levels of travel satisfaction. Individuals who believed that travel has positive utility were more satisfied with their commute compared to those who viewed it as a waste of time. Additionally, environmentally friendly commuters tended to be more satisfied with their commute. Attitudes also indirectly influenced travel satisfaction through travel mode choice. Pro-bike, pro-walk, and pro-transit attitudes were associated with less car use and more active travel and transit use for commuting. Environmentally friendly commuters were less inclined to use cars and more likely to use active travel. Interestingly, people who generally enjoyed travel were associated with increased car use and walking for daily commuting.

2.2.4 External factors influencing trip satisfaction

Important is that there also needs to be looked for positive utilities rather than traditional disutilities (St-Louis et al., 2014; Whalen et al., 2013). Key factors of commuter satisfaction are often seen as the objective aspects of a commute, such as the mode, trip cost, duration, distance, and season if applicable (St-Louis et al., 2014). Regarding travel time Turcotte (2011) found that commute satisfaction declines with increasing travel time. Paige Willis et al. (2013) discovered that seasonal variation was crucial in explaining cyclist satisfaction with reference to seasonality. More and more research focusses on the experiential dimensions of commuter satisfaction for active mode users (Adey, 2008; Middleton, 2010, 2011). The built environment and the perception of it is thus very important.

Studies have shown that the route characteristics, such as route length, terrain, and scenery, can impact cyclists' trip satisfaction (Bieger et al., 2016). They found that route quality, including factors such as road surface condition and landscape, significantly influenced cyclists' satisfaction with the route. The presence and quality of cycling infrastructure, such as dedicated bike lanes, paths, and signage, have been shown to influence trip satisfaction. Heinen et al. (2010) state that good cycling infrastructure, including separated bike lanes and clear signage, positively influenced cyclists' satisfaction with the trip. Safety is also an important factor in cyclists' trip satisfaction. Perceived safety, including factors such as traffic volume, intersections, and conflict points, significantly influenced cyclists' satisfaction with their trip (Oja et al., 2011).

2.2.5 Differences between e-bikers and regular cyclists

There have been a lot of studies on the difference in factors that influence trip satisfaction between modes like cars and bicycles. This sub paragraph tries to explore the difference in factors between e-bikes and regular bicycles.

Some limitations to *regular cycling* that are listed in a paper by Nematchoua et al. (2020) are relief, no bike path, insecurity, congestion, long distance, effort, bad weather, parking, complexity, speed, traffic, and price. This list is in order of high experienced limitations to less experienced limitations.

There is a lot known about factors that influence trip satisfaction for regular cyclists. However, there isn't a lot of research available on the factors that influence the trip satisfaction for *e-bikers*. The research that is available comes from de Kruijf et al. (2019) and Nematchoua et al. (2020). De Kruijf et al. (2019) used the following explanatory variables: household characteristics (gender, age, income, household composition, car ownership, health, education, urbanization level), work place related circumstances (flexibility of start and end working day, travel days to work, cycling distance), commute related characteristics (level of effort, crowdedness, freedom of speed, annoyance by other users, perceived unsafety, wayfinding, share of habitual commute cycling), and spatial context (perceived green, openness, liveliness/aesthetical value, atmosphere, perceived urbanization). Nematchoua et al. (2020) listed the limitations to e-cycling. From impactful to less impactful: bike path, insecurity, price, congestion, weather, distance, parking, relief, complexity, speed, effort, and traffic. The study was held in Belgium, and relief doesn't play a role in the case of Utrecht.

So, most factors are the same for regular cyclists and e-bikers. However, the order of importance of the factors differs. A long distance, for example, is a higher limitation for regular cyclists because they are not helped by an engine. In the case of weather, e-bikers don't experience wind as a limitation.

2.2.6 A way to measure trip satisfaction: STS

The Satisfaction with Travel Scale (STS) is first proposed by C. Bergstad et al. (2009). This STS contained a five-item scale that measures travel specific subjective well-being. Four cognitive evaluations are included, as well as a general affective item to measure how well-affected respondents felt after traveling. Because this STS only takes cognitive items into consideration, Ettema et al. (2011) came up with an improved STS that also takes the affective domain into account. It specifically integrates assessments of cognitive travel satisfaction with measurements of the activation and valence aspects of mood. As a result, it is compatible with how the Swedish Core Affect Scale measures affective well-being (SCAS). These aspects have been explained in paragraph 2.2.1.

Figure 2.5 shows the STS developed by Ettema et al. (2011). The combinations of the valence and activation dimensions are used to define each scale's endpoints. Six scales were developed, with three separating positive deactivation (such as relaxed) from negative activation (such as time pressed) and three separating positive activation (such as alert) from negative deactivation (such as tired). Each scale had scores ranging from -4 to 4. Three scales pertaining to the general effectiveness and quality of the transport service were used to measure cognitive evaluation of travel. Every scale is designed so that a higher score corresponds to greater satisfaction. Scores ranged between -4 and 4.

The STS has been used in multiple studies after 2011 (de Kruijf et al., 2019; Ettema et al., 2016; Olsson et al., 2013; Suzuki et al., 2014). The STS is an appropriate method to measure trip satisfaction with e-bikes in this thesis since it has consistently produced positive results across transport modes in a range of geographic contexts.

The satisfaction with travel scale (STS).

Positive deactivation–negative activation
Time pressed (−4) – relaxed (4)
Worried I would not be in time (−4) – confident I would be in time (4)
Stressed (−4) – calm (4)
Positive activation–negative deactivation
Tired (−4) – alert (4)
Bored (−4) – enthusiastic (4)
Fed up(−4) – engaged (4)
Cognitive evaluation
Travel was worst (−4) – best I can think of (4)
Travel was low (−4) – high standard (4)
Travel worked well (−4) – worked poorly

Figure 2.5 The Satisfaction with Travel Scale (STS) (Ettema et al., 2011)

2.2.7 Summarizing model

Based on the theoretical framework above on the topic of commuter satisfaction, the summarizing model below was created. The conceptual model of Chatterjee et al. (2020) about the relationship between commuting and subjective wellbeing is used as a basis. Three time zones are shown: satisfaction during travel, satisfaction after travel, and satisfaction on the long-term. The elements that affect the trip satisfaction for cyclists (no distinction between e-bikers or regular cyclists) is based on the conceptual model of Paige Willis et al. (2013). The built environment, natural environment, and trip characteristics all have an influence on the commute satisfaction during the travel. These are external factors. Directly after the trip, someone's mood can be affected. The influence of commute satisfaction on the overall subjective wellbeing on the long term has an influence on the socio-economic characteristics, demographic characteristics, and someone's values, perceptions, and attitudes. But these characteristics also influence the commute satisfaction during travel (the bi directional relationship as talked about by De Vos & Witlox (2017)) which is shown by the dotted arrow. All of these different elements in blue affect the level of trip satisfaction. See figure 2.6 for the summarizing model.

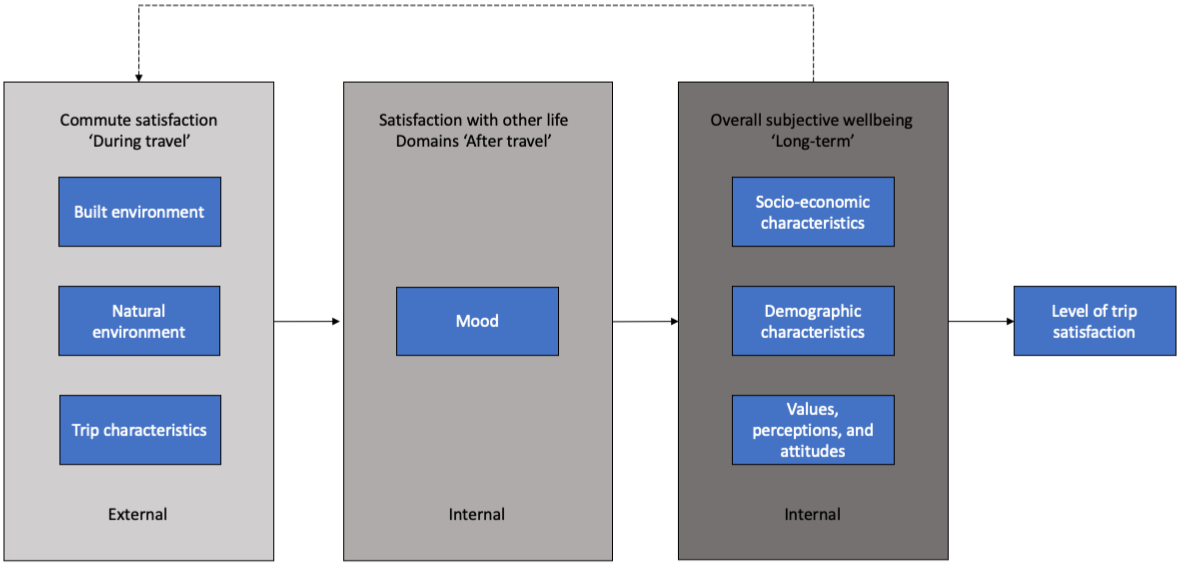

Figure 2.6 Summarizing model

2.3 Conceptual model

The conceptual model below shows the connections between the independent variable mode choice and the control variables with the dependent variable STS score. Control variables that are considered in this research are gender, education, income, occupation, age, and travel time. These are mostly socio-demographic variables which are asked about in the survey as well as the variable travel time. The last one is chosen to consider because travel time can influence the commuter satisfaction according to the literature. The independent variable is mode choice (regular bicycle / e-bike) because in order to answer the research question, the connection between mode choice and STS score needs to be tested. Because there are four models that are going to be tested, there are also four dependent variables. These are STS total, STS positive deactivation, STS positive activation, and STS cognitive evaluation. See figure 2.7 for the conceptual model.

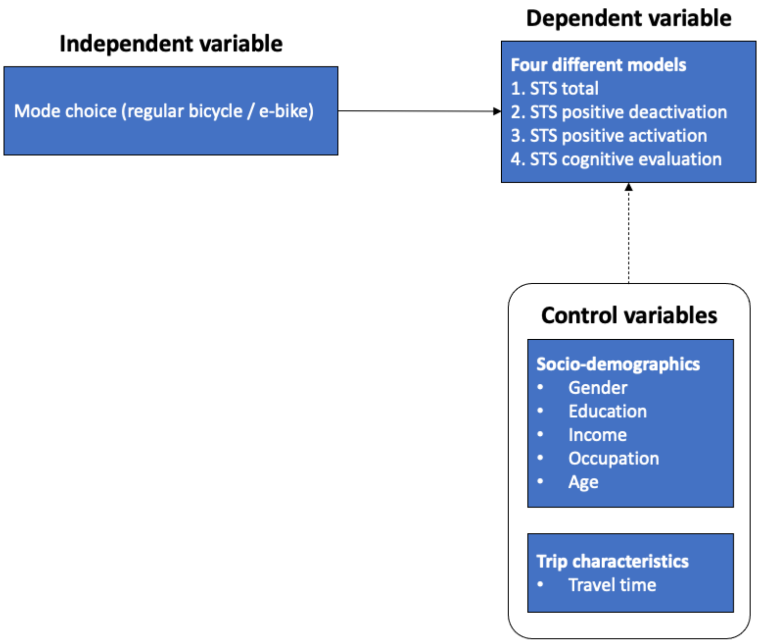

Figure 2.7 Conceptual model

3. Methods

It is now time to describe the methods employed to address the research question and its supporting sub-questions after highlighting the conceptual basis. The first part of this chapter (3.1) focusses on the research design and the description of the data. Then, a description of the sample of the survey follows (3.2). The next paragraph illustrates the operationalization (3.3). Finally, in paragraph 3.4, the steps that are followed in this research are shown.

3.1 Research design and data description

This research was conducted quantitatively. Data from the three-yearly mobility survey that was held at the Utrecht University (UU) has been made available for this research. The initial goal of the survey was to improve the university's accessibility and sustainability. Aspects that were asked about in the survey were amongst other things, socio-demographics, the mode that is used for commuting, the travel time, the role at the university, and multiple statements about the satisfaction of the commute. Respondents could win a voucher for a bicycle worth €1,000 (1x) and a gift card from Ticketmaster worth €100 (15x). The survey was held from February 15, 2023, to March 15, 2023. It took the respondents between 10 and 20 minutes to complete it. The data that had been filled in could not be traced back to a person and it complied with a privacy scan. Because data is used from another party, a secondary data analysis is conducted. The most recent data from 2023 is used. The total number of respondents is 1516. However, this number is smaller in the end because of the filtering out of everyone not commuting by regular bicycle or by e-bike. All the different locations of the different buildings of the UU are in the survey. This means that people who work/study at the Utrecht Science Park as well as people who work/study in the city centre of Utrecht and the University College Utrecht are in the survey (see figure 3.1). This survey provides a detailed view on mobility opinions and commuting habits of a lot of students, PhD students, and staff members. The population contains a high percentage of high educated people, and this is something that has been taken into account when generalizing conclusions. The study area is the city of Utrecht and the surrounding area in the heart of the Netherlands. Utrecht has a total of 361.000 inhabitants (2022). Utrecht University employs 8.500 people and hosts a number of 35.000 students.

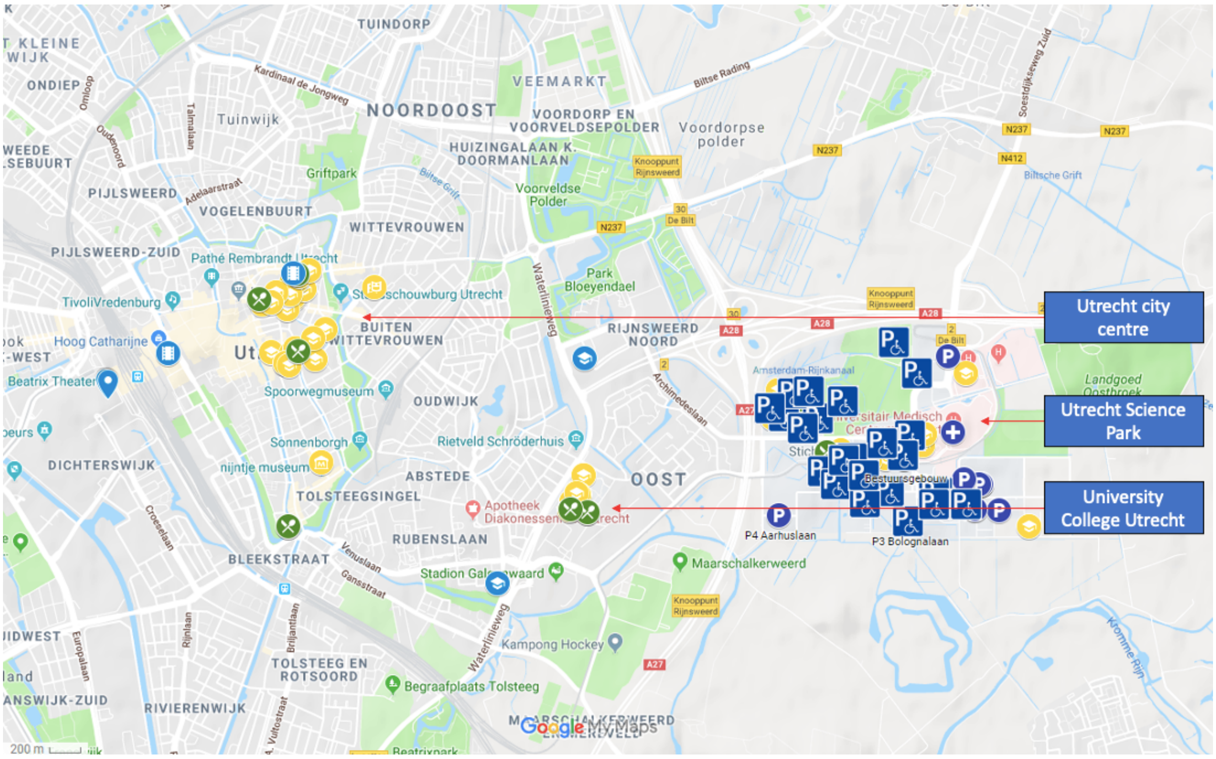

Figure 3.1 Map Utrecht University

3.2 Description of the sample

This paragraph shows the descriptive statistics of the mobility survey of the Utrecht University. It also directly answers sub question 2 (What are the differences in characteristics between e-bikers and regular cyclists?). Some variables need some more explanation. *Mode*: Respondents could answer all possible modes in the survey. However, only two modes (regular bicycle and e-bike) are used in this research, and the rest have therefore been filtered out. *Gender*: Because the group ‘other’ in the variable gender was too small, the regression model didn’t function properly. Because we want to incorporate this group in the research, there has been chosen to add the ‘other’ group to the ‘male’ group. This because in all four models, the mean of these two groups were closer together than with the ‘female’ group. *Occupation*: The new variable used in this research ‘employee’ consists of many subgroups that people could choose of. Because there were too many of these subgroups, there has been chosen to only make a difference between employees and students. *Education*: The new variable ‘lower education’ consists of people who don’t have former education, who finished secondary education (middelbare school in Dutch), and who finished vocational education (mbo in Dutch). The new variable ‘higher education’ consists of people who finished a bachelor at a university of applied sciences (hbo in Dutch) and people who finished a bachelor’s, master’s, or doctorate degree at a university.

	Total				Regular cyclists				E-bikers				Sig.
	Cat.		**Cont.**		**Cat.**		**Cont.**		**Cat.**		**Cont.**		
Variable	**#**	**%**	**Mean**	**SD**	**#**	**%**	**Mean**	**SD**	**#**	**%**	**Mean**	**SD**	
Trip characteristics	000	00.0	00.00	00.00	000	00.0	00.00	00.00	000	00.0	00.00	00.00	
Mode:													
Regular bicycle	590	82.5			-	-			-	-			
E-bike	125	17.5			-	-			-	-			
Travel time:													t=-7.22**
Travel time			23.99	11.15			22.65	10.41			30.30	12.35	
Socio-demographics													
Gender:													X^2=4.32
Female	427	59.7			342	58.0			85	68.0			
Male	260	36.4			224	38.0			36	28.8			
Other	28	3.9			24	4.0			4	3.2			
Occupation:													X^2=29.02**
Student	142	19.9			139	23.6			3	2.4			
Employee	573	80.1			451	76.4			122	97.6			
Education:													X^2=39.00**
Higher education	640	89.5			549	93.1			91	72.8			
Lower education	71	9.9			40	6.8			31	24.8			
Prefer not to answer	4	0.6			1	0.2			3	2.4			
Age:													t=-9.08**
Age			37.82	13.11			35.86	12.62			47.04	11.34	
Income:													X^2=23.37**
< 30,000	143	20.0			139	23.6			4	3.2			
30,001-60,000	183	25.6			153	25.9			30	24.0			
60,001-90,000	145	20.3			114	19.3			31	24.8			
90,001 >	109	15.2			88	14.9			21	16.8			
Prefer not to answer	135	18.9			96	16.3			39	31.2			

*** Significant at the 0.01 level*
Table 3.1 Descriptive statistics of the sample (N=715)

3.3 Operationalization

This research was conducted on a statistical basis with descriptive statistics and by testing relationships between dependent, independent, and control variables with multiple regression analysis. The statistic program SPSS is used for these analyses. STS score is the dependent variable, whereas mode (regular bike/e-bike) is the independent variable. The control variables are travel time, gender, occupation, education, age, and income. The operationalization of the variables to define the study for analysis is covered in this section.

3.3.1 Processing of the variables

It is crucial to first carry out a number of processes in order to be able to include all the essential variables in the empirical analyses: Firstly, it is essential to convert all string variables that simply contain text into numeric values in order to move further with these variables in the course of the statistical research. The string variables in this study that I need to recode are gender, education, income, and occupation. Secondly, all the variables with more than two categories and not measured at the interval level need to be recoded into dummy variables. This step is essential since dummy coding satisfies one of the main presumptions of the regression model (all independent and control variables must be measured at the interval level or as two-category categorical variables). The only variable that has been recoded is income because this variable consists of four categories.

3.3.2 Dependent variable: STS scores

The goal of this research is to find whether there is a difference in commuter trip satisfaction between regular cyclists and e-bikers. The satisfaction with Travel Scale (STS) was used to gauge participants' satisfaction with their commutes (Ettema et al., 2011). An explanation of STS scores can be found in paragraph 2.2.6. STS has been used to assess traveller satisfaction when using a car, other types of public transportation, walking and cycling, and most recently, e-bikes (de Kruijf et al., 2019). The STS is an appropriate method to gauge participant satisfaction with e-cycling since it has consistently produced consistent results across transport modes in a range of geographic contexts. In this study a three-factor scale is used to divide the nine STS scales:

Positive deactivation – Negative activation
Stressed – Calm (STS 1)
Worried I would not be in time – Confident I would be in time (STS 6)
Time pressed – Relaxed (STS 8)

Positive activation – Negative deactivation
Bored – Enthusiastic (STS 2)
Tired – Alert (STS 4)
Fed up – Engaged (STS 9)

Cognitive evaluation
Travel worked well – Worked poorly (STS 3)
Travel was low – High standard (STS 5)
Travel was worst – Best I can think of (STS 7)

These scales are based on the Swedish Core Affect Scale (SCAS) which can be seen in figure 3.2. This approach assumes that emotions may be broken down into two fundamental dimensions: activation (versus de-activation) and valence (positive versus negative). In contrast to de-activation, which is a state associated with the absence of such stimulus, activation describes how much an individual is aroused by stimuli from their surroundings. The "affect grid" can be used to determine an individual's emotional state based on their scores on both dimensions (Ettema et al., 2013).

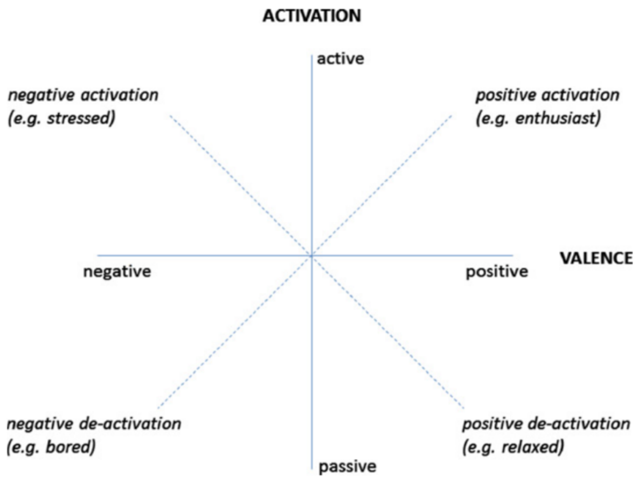

Figure 3.2 Dimensions in the Swedish Core Affect Scale (SCAS) (Västfjäll et al., 2002)

Each respondent's satisfaction with travel scores were created by averaging their responses to each of the three subscales. After that, each respondent's individual satisfaction with travel score was created by averaging their responses to all nine items. This means that there have been created four models (figure 3.3).

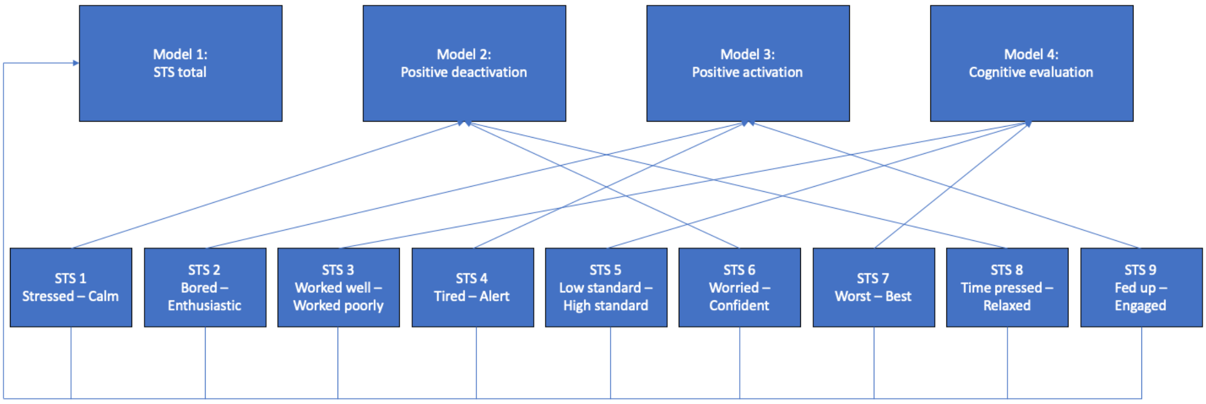

Figure 3.3 The four models used in the regression analysis

3.3.3 Independent variable: mode (regular bike/e-bike)

The respondents who stated that they use a regular bike or an e-bike have been filtered from the total results of the UU mobility survey. This leaves us with a total number of 715 people who meet the requirements and are going to be further analysed. The studied group consists of 590 people who use a regular bicycle for commuting (82.5%), and 125 people who use an e-bike for commuting (17,5%). This is visualised in figure 3.4.

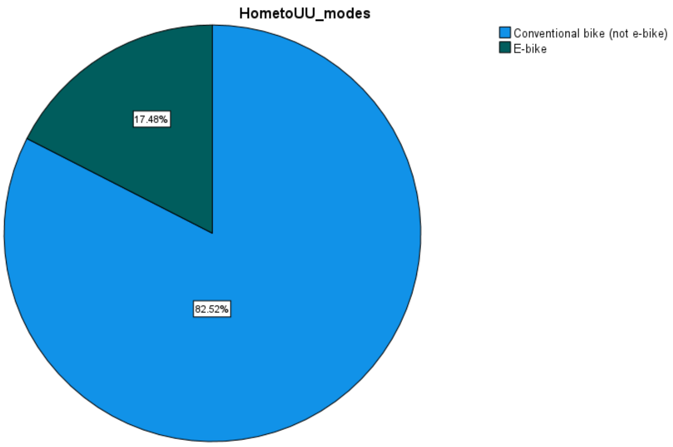

Figure 3.4 Distribution by mode

3.3.4 Control variables

It is important to include control variables in the regression analyses. Namely, the process of elaboration can help in providing theoretical and empirical proof that another causally previous control variable cannot account for the link between the independent and dependent variables. There have been added six control variables in the regression analyses, which are all introduced below. They mostly contain demographic information that has been asked in the mobility survey. By asking demographic questions, researchers can compare study participants' responses across various demographic groups. The variable 'travel time' is not a demographic variable, but it has been chosen because travel time can be experienced differently when riding on an e-bike. The significance of all variables can be found in the appendix chapter 1.

Gender

The studied group consists of 427 females (59.7%), 260 men (36.4%), 17 people who prefer not to answer (2.4%), 8 people who identify as transgender, gender non-confirming, gender fluid (1.1%), and 3 people who identify as other (0.4%).

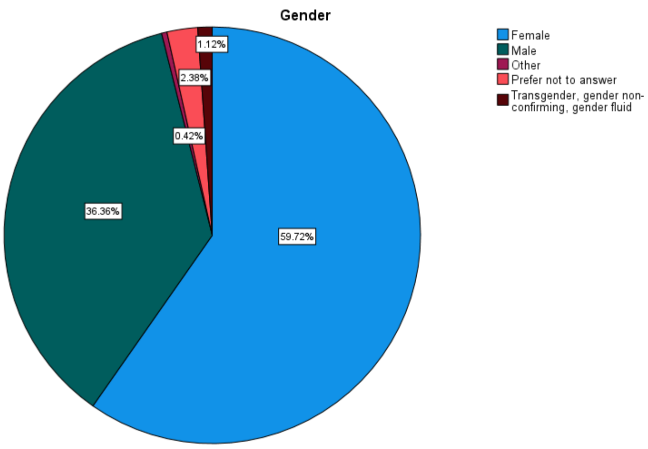

Figure 3.5 Distribution by gender

In this study it is interesting to know whether gender plays a role in the difference between e-bikers and regular cyclists.

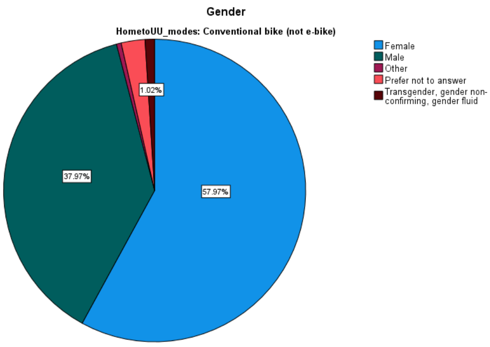

Figure 3.6 Distribution by gender regular bicycle

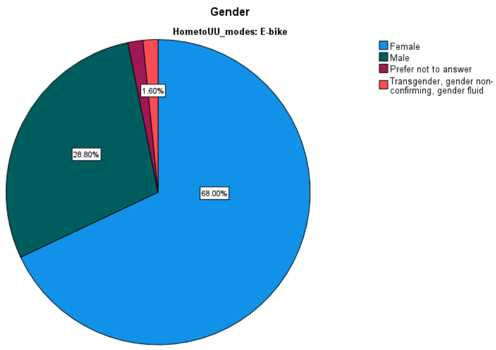

Figure 3.7 Distribution by gender e-bike

It appears that women more often commute by e-bike than men in contrast with the regular bicycle.

<u>Education</u>

The studied group consists of 640 people with higher education (89.5%), 71 people with lower education (9.9%), 4 people who prefer not to answer (0.6%).

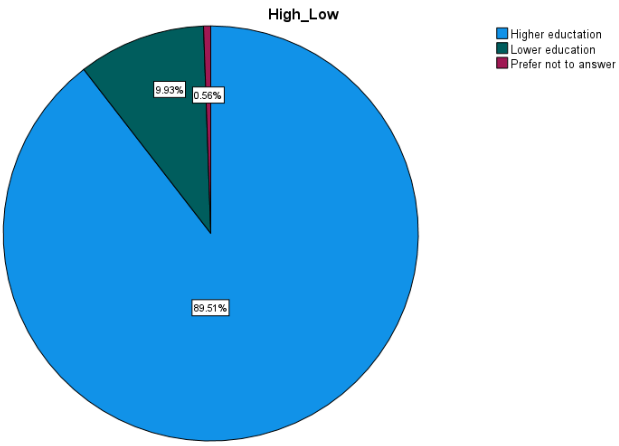

Figure 3.8 Distribution by education

In this study it is interesting to know whether education plays a role in the difference between e-bikers and regular cyclists.

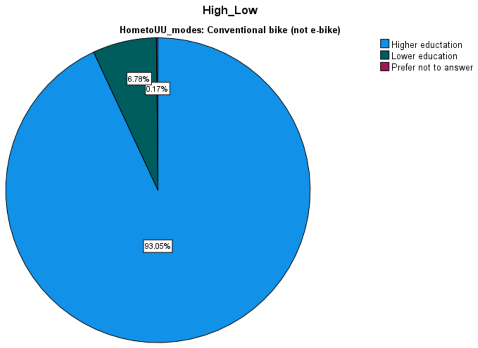

Figure 3.9 Distribution by education regular bicycle

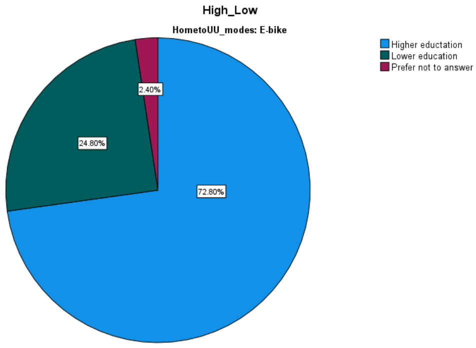

Figure 3.10 Distribution by education e-bike

It appears that the share of people with a lower education is higher in the e-biker group than in the regular bicycle group.

It has been chosen to leave out the group 'prefer not to answer' in the regression analyses because of its small size.

<u>Income</u>

The studied group consists of 143 people with an income under € 30.000 (20.0%), 183 people with an income between € 30.001 - € 60.000 (25.6%), 145 people with an income between € 60.001 - € 90.000 (20.3%), 109 people with an income above € 90.001 (15.2%), and 135 people who prefer not to answer (18.9%).

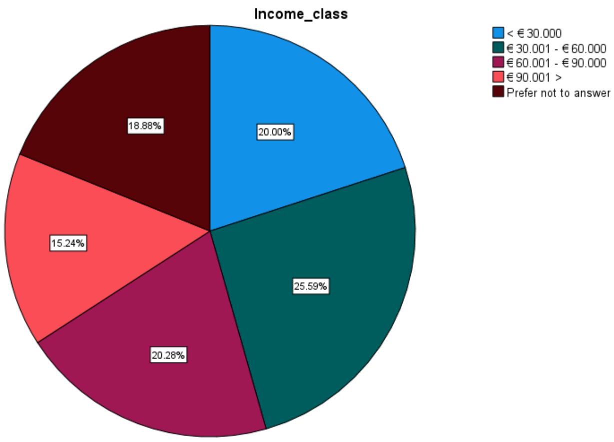

Figure 3.11 Distribution by income class

In this study it is interesting to know whether the income groups for e-bikers and regular cyclists is the same or differs.

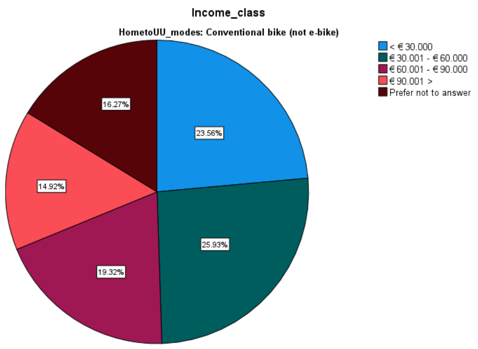

Figure 3.12 Distribution by income class regular bicycle

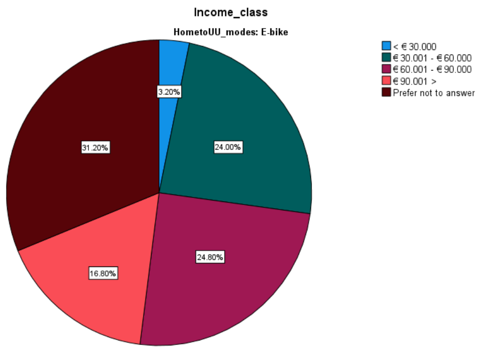

Figure 3.13 Distribution by income class e-bike

What stands out is that people with an income under the € 30,000 less often have an e-bike (3.2%), while this percentage is 23.6% in the regular cyclists group.

It has been chosen to leave out the group ‘prefer not to answer’ in the regression analyses because of its small size.

Occupation

The studied group consists of 573 people are an employee at the Utrecht University (80.1%), and 142 students at the Utrecht University (19.9%).

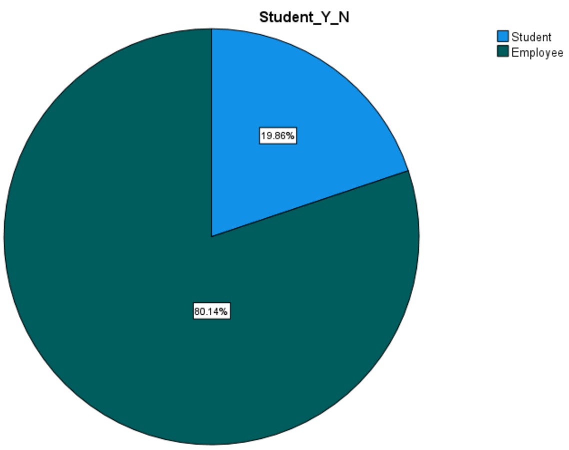

Figure 3.14 Distribution by occupation

In this study it is interesting to know whether being a student or an employee plays a role in the difference between e-bikers and regular cyclists.

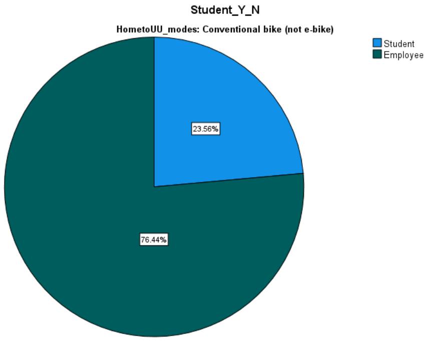

Figure 3.15 Distribution by occupation regular bicycle

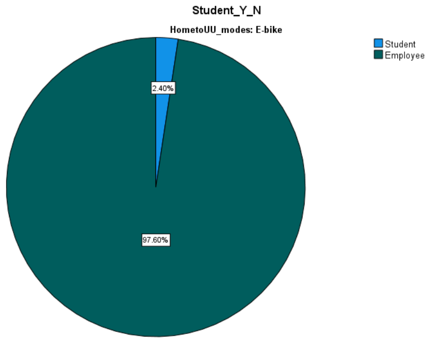

Figure 3.16 Distribution by occupation e-bike

Almost a quarter of the regular bicycle group is a student. However, only 2.4% of the e-biker group is student. This is in line with the expectations that students usually not own an e-bike.

<u>Travel time</u>

For the total group the minimum travel time is 4 minutes, and the maximum is 75 minutes. The mean travel time is 23.99 with a standard deviation of 11.15. The boxplot shows that the distribution is left-skewed.

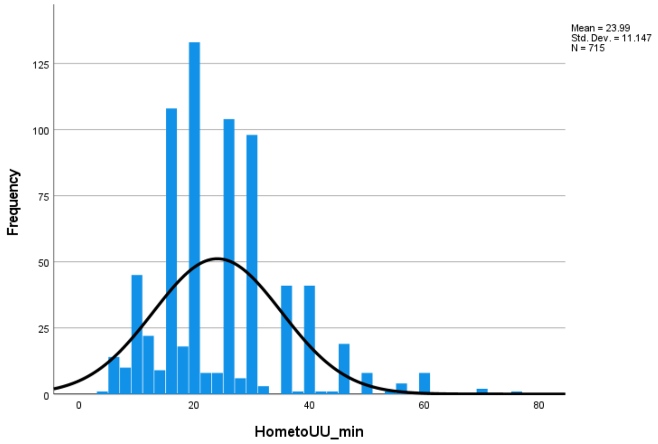

Figure 3.17 Histogram travel time

In this study it is interesting to know whether travel time plays a role in the difference between e-bikers and regular cyclists. The minimum travel time of the regular cyclists group is 4 minutes while the maximum is 70 minutes. The mean travel time for this group is 22.65 minutes with a standard deviation of 10.41. For the e-bikers the minimum is 6 minutes and the maximum 75 minutes. The mean travel time for this group is 30.30 minutes with a standard deviation of 12.35.

The regular cyclists group is left skewed, while the e-bikers group is more normally distributed.

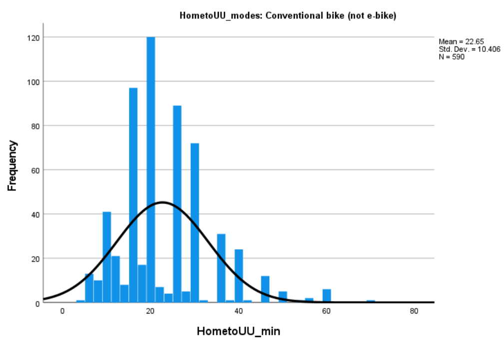

Figure 3.18 Histogram travel time regular bicycle

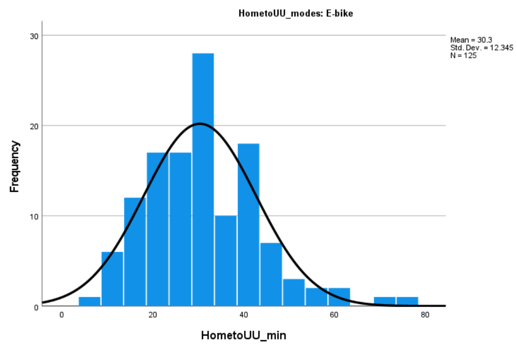

Figure 3.19 Histogram travel time e-bike

The independent samples t-test shows that equal variances are assumed. The difference in mean travel time for regular cyclists (*M* = 22.65; *SD* = 10.41) and e-bikers (*M* = 30.30; *SD* = 12.35) was significant (*t* (713) = -7.22; *p* < .001).

Age

The minimum age of the studied group is 19 years old, and the maximum age is 68 years old. The mean age is 37.82 years old with a standard deviation of 13.11. The histogram shows that the age is normally distributed.

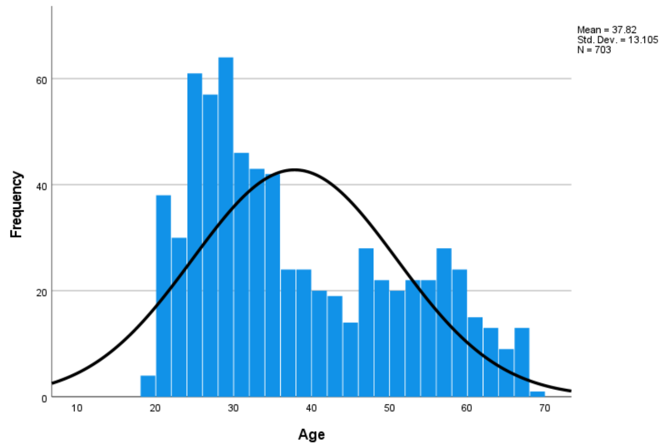

Figure 3.20 Histogram age

In this study it is interesting to know whether the mean age for e-bikers and regular cyclists is the same or differs. The mean age for the regular cyclists group is 35.86 years old with a standard deviation of 12.62. The mean age for the e-bikers group is 47.04 years old with a standard deviation of 11.34. So, the e-bikers group is a lot older on average.

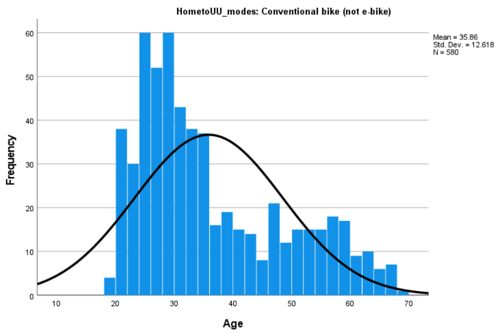

Figure 3.21 Histogram age regular bicycle

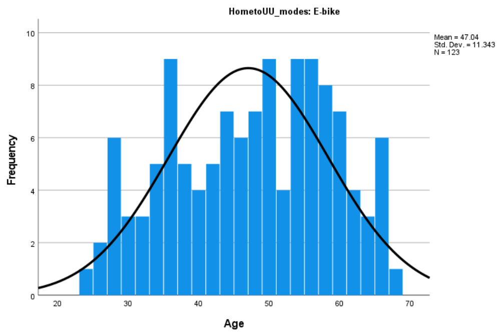

Figure 3.22 Histogram age e-bike

The independent samples t-test shows that equal variances are assumed. The difference in mean age for regular cyclists (*M* = 35.86; *SD* = 12.62) and e-bikers (*M* = 47.04; *SD* = 11.34) was significant (*t* (701) = -9.08; *p* < .001).

3.4 Analyses steps

First, there have been created a correlation matrix for the nine items of the STS. This provides valuable insights into the relationships among these items, and it can be tested if the correlations are significant. This is done three times: for the regular cyclists group, the e-bikers group, and the total population. Secondly, there has been tested whether there is internal consistency. This is done with Cronbach's alpha for the four scales: positive deactivation, positive activation, cognitive evaluation, and the total STS scores. Thirdly, mean STS scores are compared for the four different scales to get an answer to the research question ("Do e-bike users have a higher trip satisfaction on their ride to and from the different locations of the Utrecht University compared to regular bicycle users?"). To test for the control variables, regression analyses will be conducted. The regression analyses are conducted to determine which factors matter the most, and which can be ignored. In the last step the factor that can be ignored because it gives wrong results (occupation) is left out and the regression analyses will be conducted again to gain better results. Four models will be tested for the four different scales.

4. Results

In order to prepare for an answer to the sub-questions and the main question, the findings of the analysis are reviewed in this chapter. SPSS was used to conduct the analysis. The steps performed in the analysis are outlined in further detail where necessary.

4.1 Correlations and descriptive statistics

The correlation matrix of the different STS scores is shown in this chapter. As well as some other descriptive statistics regarding the independent variables.

<u>4.1.1 General commute satisfaction</u>

The general commute satisfaction is based on a score that people gave on the following question: “In general, how satisfied are you with your trip to and from work during pleasant weather conditions?” So, this question gives an impression of the satisfaction of the commute of the respondents. This question was asked before going deeper into the nine individual STS scores. Respondents could gave a score between -3 and 3. Regular cyclists rated their commute with a 2.61 on average with a standard deviation of 0.67. E-bikers rated their commute with a 2.72 on average with a standard deviation of 0.58. The average for e-bikers is slightly higher what means a higher trip satisfaction on average. E-bikers gave a minimum STS score of 0, while regular cyclists gave a minimum score of -2. For both groups the maximum score given is 3. If this is put in a boxplot, it is visualised as shown below.

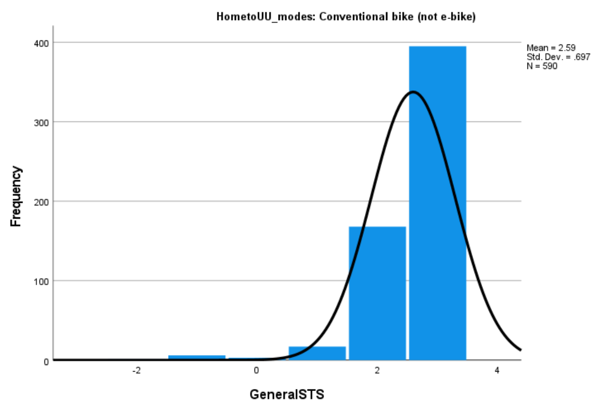

Figure 4.1 Histogram general commute satisfaction regular bicycle

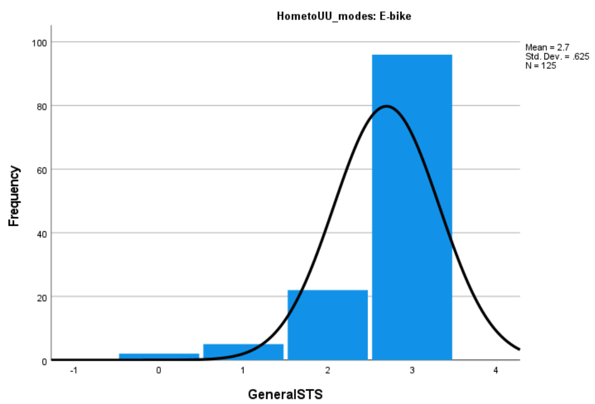

Figure 4.2 Histogram general commute satisfaction e-bike

The independent samples t-test shows that equal variances are not assumed. The difference in general STS score for regular cyclists (*M* = 2.61; *SD* = 0.67) and e-bikers (*M* = 2.72; *SD* = 0.58) was significant (*t* (200) = -1.89; *p* < .030). The whole t-test is shown in the appendix chapter 2.

4.1.2 Individual STS scores (1-9)

The table below shows the correlation matrix, the means, the standard deviations, the skewness, and the kurtosis of the individual STS scores of the **total population**. The tables that are split out between regular cyclists and e-bikers is shown in the appendix chapter 3.

	1	2	3	4	5	6	7	8	9
STS1 Stressed - Calm	1.00								
STS2 Bored - Enthousiastic	0.34**	1.00							
STS3 Worked poorly - Worked well	0.39**	0.37**	1.00						
STS4 Tired - Alert	0.32**	0.48**	0.33**	1.00					
STS5 Low standard - High standard	0.33**	0.47**	0.44**	0.38**	1.00				
STS6 Worried - Confident	0.35**	0.28**	0.26**	0.32**	0.27**	1.00			
STS7 Worst imaginable - Best imaginable	0.30**	0.34**	0.41**	0.32**	0.55**	0.26**	1.00		
STS8 Pressed - Relaxed	0.48**	0.34**	0.31**	0.36**	0.33**	0.65**	0.37**	1.00	
STS9 Fed up - Engaged	0.39**	0.63**	0.38**	0.50**	0.53**	0.38**	0.49**	0.44**	1.00
Mean	1.90	1.12	2.20	1.01	1.36	1.80	1.37	1.44	1.29
Standard deviation	1.30	1.23	1.14	1.57	1.22	1.64	1.16	1.54	1.25
Skewness	-1.43	-0.39	-1.79	-0.57	-0.55	-1.23	-0.53	-0.82	-0.48
Kurtosis	1.62	-0.27	3.32	-0.57	-0.03	0.31	0.36	-0.30	-0.18

*Table 4.1 Correlation matrix, means, standard deviations, skewness, and kurtosis of the STS scores of the **total population***
*** Correlation is significant at the 0.01 level*
** Correlation is significant at the 0.05 level*

In all three cases, the nine items are positively correlated with each other at the 0.01 level (p < 0.01) or in some cases at the 0.05 level (p < 0.05).

When we look at the differences in means between the regular cyclists and the e-bikers, e-bikers are more satisfied in every STS score. This is visualised in the overview below.

	STS1	STS2	STS3	STS4	STS5	STS6	STS7	STS8	STS9
Regular cyclists	1.85	1.06	2.16	0.96	1.29	1.74	1.34	1.37	1.19
E-bikers	2.09	1.42	2.35	1.27	1.66	2.08	1.52	1.77	1.79
Difference	0.24	0.36	0.19	0.31	0.37	0.34	0.18	0.40	0.60
Sig. (t-test)	0.034*	0.002**	0.046*	0.021*	0.001**	0.011*	0.061	0.005**	0.001**

*** Correlation is significant at the 0.01 level*
** Correlation is significant at the 0.05 level*
Table 4.2 Differences in means between STS scores

The biggest difference (0.60) in STS score is in STS9, which means that e-bikers are more engaged with their commute in general. The next biggest difference (0.40) is in STS8, which means that e-bikers are more relaxed during their commute. E-bikers also have a higher score in STS5 (0.37), which means that they view their commute as a higher standard.

4.1.3 Three factor scale

Here we move on to the three factor scales: positive deactivation, positive activation, and cognitive evaluation. The mean of all nine individual STS scores is also considered ('All STS' in the table below). The table below shows the Cronbach's alpha for the three-factor scale, as well as the mean split out into regular cyclists and e-bikers. All three scales show a Cronbach's alpha between 0.7 and 0.8. This means that the internal consistency is 'acceptable'. For all nine individual STS scores combined, the internal consistency is even higher at the 'good' level.

	Positive deactivation	**Positive activation**	**Cognitive evaluation**	**All STS**
Mean regular cyclists	1.65	1.07	1.60	1.44
Mean e-bikers	1.98	1.49	1.84	1.77
Difference	0.33	0.42	0.24	0.33
Cronbach's alpha	0.75	0.77	0.72	0.85

Table 4.3 Means and Cronbach's alpha in the three factor scale

4.1.4 Sub conclusion

This paragraph has shown that all the different descriptives of the STS scores are good to start the regression analysis in the next paragraph. The general STS score is significant and already shows a slightly higher overall trip satisfaction for e-bikers. All the nine individual STS scores are positively correlated and are all significant except for STS7. All individual scores also show a higher trip satisfaction for e-bikers. Finally, the individual STS scores are grouped into the three factor scale and it is shown that they all have internal consistency measured with a Cronbach's alpha.

4.2 Multiple linear regression analyses

Four multiple linear regression analyses have been conducted. These are done for 'positive deactivation', 'positive activation', 'cognitive evaluation', and for all STS scores combined. This paragraph starts with the assumptions and then the regression analyses follow.

4.2.1 Assumptions

Before running a multiple regression analysis, the assumptions need to be tested. There are five assumptions that are tested in this sub paragraph. This will be done for the four different models separately. First the general ideas behind the assumptions will be shown. The total elaboration of the assumptions can be found in the appendix chapter 4.

1. Variable types

All independent and control variables, according to the first supposition, must either be continuous, ordinal, or categorical. The dependent variable must be measured at the interval or ratio level. The final condition for the dependent variable simply states that there should be no restrictions on the outcome's variability. For instance, if an outcome variable is measured on a scale from 1 to 10, but the data collected only cover the range from 3 to 7, the outcome is restricted.

All of the variables utilized in this study are either categorical variables or interval scale measurements. Additionally, the dependent variable of the STS scales vary from -3 to 3 and this is measured at the ordinal level. It can be argued that this variable is non-constrained and continuous. As a result, the assumption regarding the type of the variables has been fulfilled.

2. Normality

The residuals from the regression should adhere to a normal distribution in order to draw reliable conclusions from it. The error terms, or the discrepancies between the observed and predicted values of the dependent variable, make up the residuals. If the residuals are normally distributed, it can be told by looking at a normal Predicted Probability (P-P) plot.

All four dependent variables of the four models are normally distributed (see appendix chapter 4). So, this assumption is met.

3. Homoscedasticity

Homoscedasticity describes whether the residuals are randomly distributed or if they tend to cluster at some values while dispersing widely at other values. If the data resembles a shotgun discharge of randomly distributed data, it is homoscedastic. Heteroscedasticity, which is the reverse of homoscedasticity, might cause the data to take the shape of a cone or fan. Plotting the expected values and residuals on a scatterplot allows it to verify this assumption.

All four dependent variables of the four models are homoscedastic (see appendix chapter 4). So, this assumption is met.

4. Linearity

When a regression is said to be linear, it signifies that the connection between the predictor variables and the outcome variable is linear. There only need to be worried about linearity if the residuals are not normally distributed and not homoscedastic.

Because all four models are normally distributed and homoscedastic, this assumption does not have to be tested.

5. No multicollinearity

When the predictor variables have a strong correlation with one another, this is referred to as multicollinearity. This is a problem since it will result in confusing results and false conclusions because the regression model won't be able to precisely link variance in your outcome variable with the appropriate predictor variable. This assumption only needs to be tested when conducting *multiple* linear regression, which is the case. The VIF score needs to be below 10 in order to not have multicollinearity. All VIF scores of the independent variables are below 10 what means that there is no multicollinearity (see appendix chapter 4).

All assumptions are met, so the multiple regression can be conducted. The results are shown below.

4.2.2 Results multiple linear regression

This sub paragraph shows the four different multiple linear regression analyses that have been conducted.

Model 1 'positive deactivation'

Multiple linear regression was used to test if mode significantly predicted STS score for positive deactivation with control variables gender, education, income, occupation, travel time, and age. Mode choice did not significantly predict STS score for positive deactivation with R^2 = .125, F(9, 562) = 8.955, p = 0.001).

	Step 1				Step 2			
	B	**s.e.**	**Beta**	**p**	**B**	**s.e.**	**Beta**	**p**
Constant	.897*	.329	-	.007	.846*	.364	-	.020
Regular bicycle (mode)	-	-	-	-	-.048	.147	.014	.746
E-bike (mode) *reference*	-	-	-	-	-	-	-	-
Male + Other (gender)	.120	.098	.048	.225	.123	.099	.050	.216
Female (gender) *reference*	-	-	-	-	-	-	-	-
Higher education (education)	-.045	.175	-.011	.796	-.034	.178	-.008	.847
Lower education (education) *reference*	-	-	-	-	-	-	-	-
< €30,000 (income)	.115	.194	.041	.554	.117	.194	.042	.548
€30,000 - €60,000 (income)	.062	.145	.024	.667	.062	.145	.024	.669
€60,000 - €90,000 (income)	.221	.149	.079	.139	.219	.150	.078	.145
> €90,000 (income) *reference*	-	-	-	-	-	-	-	-
Student (occupation)	-.367*	.180	-.122	.042	-.366*	.180	-.122	.043
Employee (occupation) *reference*	-	-	-	-	-	-	-	-
Travel time	-.009	.005	-.081	.052	-.009*	.005	-.083	.049
Age	0.27**	.005	.281	.001	.026**	.005	.278	.001
R-square	.125				.125			
Change in R-square					.000			
*** p < 0,05 ** p < 0,01**								

Table 4.4 Results for model 1 'positive deactivation'

It was found that occupation (student/employee) significantly predicted positive deactivation in both steps (β = -.367, p = .042 / β = -.366, p = .043) with employees being more satisfied with their trip. It was found that age significantly predicted positive deactivation in both steps (β = .270, p = .001 / β = .026, p = .001). When respondents were older, their trip satisfaction was generally higher. It was found that travel time significantly predicted positive deactivation in step 2 (β = -.009, p = .049). When respondents had a longer travel time, their trip satisfaction was generally lower.

The independent variable 'mode' seems to not significantly predict positive deactivation.

<u>Model 2 'positive activation'</u>

Multiple linear regression was used to test if mode significantly predicted STS score for positive activation with control variables gender, education, income, occupation, travel time, and age. Mode choice did not significantly predict STS score for positive activation with R^2 = .147, F(9, 562) = 10.776, p = 0.001).

	Step 1				**Step 2**			
	B	**s.e.**	**Beta**	**p**	**B**	**s.e.**	**Beta**	**p**
Constant	.390	.293	-	.184	.246	.324	-	.448
Regular bicycle (mode)	-	-	-	-	-.135	.131	.014	.303
E-bike (mode)	-	-	-	-	-	-	-	-
Male + Other (gender)	-.064	0.88	-.029	.468	-.055	.088	-.025	.531
Female (gender)	-	-	-	-	-	-	-	-
Higher education (education)	-.161	.156	-.041	.304	-.129	.159	-.033	.416
Lower education (education)	-	-	-	-	-	-	-	-
< €30,000 (income)	.031	.173	0.12	.859	.036	.173	.014	.835
€30,000 - €60,000 (income)	-.271*	.130	-.115	.037	-.271*	.130	-.115	.037
€60,000 - €90,000 (income)	-.050	.133	-.020	.705	-.058	.133	-.023	.663
> €90,000 (income)	-	-	-	-	-	-	-	-
Student (occupation)	-.199	.161	-.073	.217	-.195	.161	-.072	.224
Employee (occupation)	-	-	-	-	-	-	-	-
Travel time	-.001	.004	-.012	.769	-.002	.004	-.018	.671
Age	0.29**	.004	.342	.001	.029**	.004	.332	.001
R-square	.146				.147			
Change in R-square					.001			
*** p < 0,05 ** p < 0,01**								

Table 4.5 Results for model 2 'positive activation'

It was found that having an income between €30.001 and €60.000 significantly predicted positive activation in both steps (β = -.271, p = .037 / β = -.271, p = .037).

It was found that age significantly predicted positive activation in both steps (β = .029, p = .001 / β = .029, p = .001). When respondents were older, their trip satisfaction was generally higher.

The independent variable 'mode' seems to not significantly predict positive activation.

<u>Model 3 'cognitive evaluation'</u>

Multiple linear regression was used to test if mode significantly predicted STS score for cognitive evaluation with control variables gender, education, income, occupation, travel time, and age.

Mode choice did not significantly predict STS score for cognitive evaluation with R^2 = .083, F(9, 562) = 5.629, p = 0.001).

	Step 1				Step 2			
	B	**s.e.**	**Beta**	**p**	**B**	**s.e.**	**Beta**	**p**
Constant	1.376**	.263	-	.001	1.148**	.290	-	.001
Regular bicycle (mode)	-	-	-	-	-.214	.117	.080	.068
E-bike (mode)	-	-	-	-	-	-	-	-
Male + Other (gender)	.000	.079	.000	.998	.014	.079	.007	.862
Female (gender)	-	-	-	-	-	-	-	-
Higher education (education)	.009	.140	.003	.947	.059	.142	.018	.680
Lower education (education)	-	-	-	-	-	-	-	-
< €30,000 (income)	-.020	.155	-.009	.900	-.011	.155	-.005	.943
€30,000 - €60,000 (income)	-.250*	.116	-.123	.032	-.251*	.116	-.123	.031
€60,000 - €90,000 (income)	0.42	.119	0.19	.726	.030	.119	.014	.803
> €90,000 (income)	-	-	-	-	-	-	-	-
Student (occupation)	-.240	.144	-.103	.096	-.235	.144	-.101	.102
Employee (occupation)	-	-	-	-	-	-	-	-
Travel time	-.007	.004	-.074	.081	-.007*	.004	-.084	.049
Age	.014**	.004	.193	.001	.013**	.004	.176	.001
R-square	.077				.083			
Change in R-square					.006			
*** p < 0,05 ** p < 0,01**								

Table 4.6 Results for model 3 'cognitive evaluation'

It was found that having an income between €30.001 and €60.000 significantly predicted cognitive evaluation in both steps (β = -.250, p = .032 / β = -.251, p = .031).
It was found that age significantly predicted cognitive evaluation in both steps (β = .014, p = .001 / β = .013, p = .001). When respondents were older, their trip satisfaction was generally higher.
It was found that travel time significantly predicted cognitive evaluation in step 2 (β = -.007, p = .049). When respondents had a longer travel time, their trip satisfaction was generally lower.

The independent variable 'mode' seems to not significantly predict cognitive evaluation.

Model 4 Overall STS score

Multiple linear regression was used to test if mode significantly predicted overall STS score with control variables gender, education, income, occupation, travel time, and age. Mode choice did not significantly predict overall STS score with R^2 = .165, F(9, 562) = 12.339, p = 0.001).

	Step 1				**Step 2**			
	B	**s.e.**	**Beta**	**p**	**B**	**s.e.**	**Beta**	**p**
Constant	.887**	.235	-	.001	.747*	.260	-	.004
Regular bicycle (mode)	-	-	-	-	-.132	.105	.053	.207
E-bike (mode)	-	-	-	-	-	-	-	-
Male + Other (gender)	.019	.070	.010	.791	.027	.071	.015	.702
Female (gender)	-	-	-	-	-	-	-	-
Higher education (education)	-.066	.125	-.021	.600	-.035	.127	-.011	.783
Lower education (education)	-	-	-	-	-	-	-	-
< €30,000 (income)	.042	.139	.021	.142	.047	.139	.023	.733
€30,000 - €60,000 (income)	-.153	.104	-.080	.507	-.153	.104	-.080	.140
€60,000 - €90,000 (income)	.071	.107	.034	.791	.063	.107	.031	.553
> €90,000 (income)	-	-	-	-	-	-	-	-
Student (occupation)	-.269*	.129	-.122	.037	-.265*	.128	-.121	.039
Employee (occupation)	-	-	-	-	-	-	-	-
Travel time	-.006	.003	-.068	.093	-.006	.003	-.075	.067
Age	.023**	.003	.338	.001	.023**	.003	.327	.001
R-square	.163				.165			
Change in R-square					.002			
*** p < 0,05 ** p < 0,01**								

Table 4.7 Results for model 4 'Overall STS score'

It was found that occupation (student/employee) significantly predicted overall STS score in both steps (β = -.269, p = .037 / β = -.265, p = .039) with employees being more satisfied with their trip.

It was found that age significantly predicted overall STS score in both steps (β = .023, p = .001 / β = .023, p = .001). When respondents were older, their trip satisfaction was generally higher.

The independent variable 'mode' seems to not significantly predict the overall STS score.

4.2.3 Sub conclusion 1

This sub paragraph will give a few closing notes concerning the regression analysis findings from above. In all four different regression models, the change in R-square is very small when the variable 'mode' is added. This variable is also not significant in any of the models. This means that mode choice (riding a regular bicycle or an e-bike) doesn't have a significant influence on the trip satisfaction (STS score). However, the control variable that does have an influence on trip satisfaction is in all four models 'age'. It seems that the older the people are, the higher the trip satisfaction. The control variable 'occupation' (being a student or not) was significant in the positive deactivation model and the overall STS model. In the PD model this means that employees generally experience more positive deactivation what means that they are more relaxed and calmer during their commute. Having an 'income between €30,000 and €60,000' was significant in the positive activation model and the cognitive evaluation model. This means that in the PA model people with this income are less positively activated what means that they are less enthusiastic and engaged. In the CE model this means that this group experiences their commute as less easy and less comfortable. The control variable 'travel time' was significant in the CE model. This means that people with a lower travel time, experience their commute as easier and more comfortable. The fact that e-bikers have a higher commute satisfaction is most probably because this group is older and is more often employee on average.

Because the control variables age and occupation were significant in almost all models, there will now be run four multiple linear regression models that exclude students. In this case it can be explicitly tested whether there is a difference in commuter trip satisfaction between regular cyclists and e-bikers.

4.2.4 Results multiple linear regression without students

This subparagraph will only briefly who the results of the four multiple linear regression models. The detailed SPSS results can be found in the appendix chapter 5.

Model 1 'positive deactivation'

In this model, the independent variable 'mode' doesn't cause a significant change in R-square. The only variable that is significant is 'age' ($p<.001$).

Model 2 'positive activation'

In this model, the independent variable 'mode' doesn't cause a significant change in R-square. The variables that are significant are 'income between €30.001-€60.000' ($p = .038$) and 'age' ($p<.001$).

Model 3 'cognitive evaluation'

In this model, the independent variable 'mode' does cause a significant change in R-square ($p = .032$). The other variables that are significant are 'income between €30.001-€60.000' ($p = .028$) and 'age' ($p<.001$).

Model 4 Overall STS score

In this model, the independent variable 'mode' doesn't cause a significant change in R-square. The only variable that is significant is 'age' ($p<.001$).

4.2.5 Sub conclusion 2

This sub paragraphs will give a few closing notes concerning the regression analysis findings from above. In three of the four different regression models, the change in R-square is very small when the variable 'mode' is added. This variable is also not significant in any of the three models. This means that mode choice (riding a regular bicycle or an e-bike) doesn't have a significant influence on the commuter trip satisfaction (STS score). Only in model 3 (cognitive evaluation) the independent variable 'mode' is significant ($p = .032$). In the CE model this means that the regular bicycle group experiences their commute as less easy and less comfortable than the e-biker group.

Regarding the control variables, 'age' seems to have an influence on trip satisfaction in all four models. It seems that the older the people are, the higher the trip satisfaction (the same as in the first regression analysis in 4.2.2). Having an 'income between €30,000 and €60,000' was significant in the positive activation model and the cognitive evaluation model (the same as in the first regression analysis in 4.2.2). This means that in the PA model people with this income are less positively activated what means that they are less enthusiastic and engaged. In the CE model this means that this group experiences their commute as less easy and less comfortable. In contrast with the first regression analysis in 4.2.2, the control variable 'travel time' was not significant in any model. This means that travel time doesn't have an influence on commuter trip satisfaction.

5. Conclusion and discussion

This chapter contains the conclusion and the discussion of the topic. It summarizes the results of the research in order to answer the research questions in the first paragraph (5.1). Then, the discussion is handled (5.2). Finally, recommendations are made for further research in paragraph 5.3.

5.1 Conclusion

This researched aimed to discover the possible difference in commuter trip satisfaction between regular cyclists and e-bikers. In other words: what group rates their commute the highest? This was done by looking at multiple factors that influence trip satisfaction. Having an insight in this can have many advantages for society.

In order to fulfil this aim, the following research question was drafted:

> *"Do e-bike users have a higher trip satisfaction on their ride to and from the different locations of the Utrecht University compared to regular bicycle users?"*

The following sub questions were drafted to answer the research question above:

1. *What elements contribute to the experience of the commute for e-bikers and is there a difference between regular cyclists?*
2. *What are the differences in characteristics between e-bikers and regular cyclists?*
3. *What is the role of distance in commute satisfaction between e-bikers and regular cyclists?*

This research was conducted quantitatively. Data from the three-yearly mobility survey that was held at the Utrecht University (UU) has been made available for this research. The most recent data from 2023 was used. The total number of respondents is 1516. However, this number is smaller in the end because of the filtering out of everyone not commuting by regular bicycle or by e-bike. This survey provided a detailed view on mobility opinions and commuting habits of a lot of students, PhD students, and staff members. The population contains a high percentage of high educated people, and this is something that has been taken into account when generalizing conclusions. The study area is the city of Utrecht and the surrounding area in the heart of the Netherlands. An answer to the research question was sought by means of multiple linear regression analysis.

The satisfaction with Travel Scale (STS) by Ettema et al. (2011) was used to gauge participants' satisfaction with their commutes. The STS consists of nine different items that respondents could answer with a rating between -4 and 4. These nine items are then grouped into three new scales: positive deactivation, positive activation, and cognitive evaluation. Each respondent's satisfaction with travel scores were created by averaging their responses to each of the three subscales. After that, each respondent's individual satisfaction with travel score was created by averaging their responses to all nine items into the new dependent variable STS total. This means that there have been created four multiple linear regression models.

The statistics program SPSS was used for these analyses. STS score is the dependent variable, whereas mode (regular bike/e-bike) is the independent variable. Before conducting the regression analyses, the other elements that contribute to the experience of the commute were explored (**sub question 1**). Scientific literature made clear what other elements affect the satisfaction. Therefore, the control variables that are used are travel time, gender, occupation, education, age, and income. Literature also made clear that the most important difference between regular cyclists and e-bikers is travel time (**sub question 2**). Therefore, there was paid extra attention to this control variable.

The results of the regression analyses show that in all four different regression models, the change in R-square is very small when the variable 'mode' is added. This means that mode choice (riding a regular bicycle or an e-bike) doesn't have a significant influence on the trip satisfaction (STS score). However, the control variable that does have an influence on trip satisfaction is in all four models 'age'. It seems that the older the people are, the higher the trip satisfaction. The control variable 'occupation' (being a student or not) was significant in the positive deactivation model and the overall STS model. The fact that e-bikers have a higher commute satisfaction is most probably because this group is older and is more often employee on average as is shown by the descriptive statistics. Because the control variables 'age' and 'occupation' were significant in almost all models, the next step was to run four new multiple linear regression models that excluded the students. In this case it could be explicitly tested whether there was a difference in commuter trip satisfaction between regular cyclists and e-bikers.

This time, in three of the four different regression models, the change in R-square is very small when the variable 'mode' is added. This means that mode choice (riding a regular bicycle or an e-bike) doesn't have a significant influence on the commuter trip satisfaction (STS score). Only in model 3 (cognitive evaluation) the independent variable 'mode' is significant. In the CE model this means that the regular bicycle group experiences their commute as less easy and less comfortable than the e-biker group. Again, 'age' seems to have an influence on trip satisfaction in all four models. It seems that the older the people are, the higher the trip satisfaction.

There only rests one sub question to be answered (**sub question 3**). Namely, finding out what the role of distance is in commute satisfaction. The control variable 'travel time' was not significant in any model of the second regression analyses. This means that travel time doesn't have a significant influence on commuter trip satisfaction.

With all this information, the **research question** can now be answered: E-bikers only experience a significant higher trip satisfaction than regular cyclists in the cognitive evaluation model. This means that e-bikers are more satisfied in terms of easy use and comfort. In the other three models, there doesn't seem to be a significant difference between the two groups.

5.2 Discussion

The results partially meet the expectations. It was expected that e-bikers were significantly more satisfied with their commute in every model. This was mainly hypothesised because riding an e-bike costs less energy for the rider. E-bikers are not more enthusiastic or engaged as regular cyclists (positive activation). They are not more relaxed or calm (positive deactivation). And finally, their overall satisfaction over the nine individual STS scores is also not higher. However, they do experience their commute as easier and more comfortable (cognitive evaluation). So, the possible explanation for that is that riding an e-bike costs less energy as hypothesised. The higher comfort can especially be the case in windy weather. Or it can have something to do with not arriving too tired or sweaty at work.

The earlier mentioned study conducted by Nematchoua et al. (2020) reported that e-bike users were more satisfied with their trips than regular bicycle users. The results that are found in this study are different from the study by Nematchoua et al. This can be the case because they based their conclusion on a Net Promoter Score (NPS) and only 14 respondents in their survey used e-bikes. This means that their results were derived from individuals' likelihood to recommend e-bike travel rather than their actual experiences with e-bikes. Other studies on the differences in commuter trip satisfaction between regular cyclists and e-bikers do not yet exist. Therefore, the results found in this study can complement the findings by Nematchoua et al. and fill up the knowledge gap. This research also put the e-bike slightly higher in the existing list of most satisfied modes that are established by many researchers (Chatterjee et al., 2020; Handy & Thigpen, 2019; Humagain & Singleton, 2020; St-Louis et al., 2014; Wild & Woodward, 2019).

The survey used was not designed and conducted by the researcher, nor in the light of this study. This may entail limitations. In the case of this study, other explanatory variables could be included for an even better picture. Examples of variables that, according to the literature, are also important in determining trip satisfaction are: the built environment, physical condition, someone's values, and perceptions. The way of measuring satisfaction by means of the STS was a good part of the survey because this scale is often used in such research. With regard to the statements made about the students, it is necessary to bear in mind that they are university students. So, nothing is known about students of other educational levels or young people/young adults in general.

This study has some other limitations. (1) It is beyond the scope of this study to address questions that delve deeper into the differences between regular cyclists and e-bikers. This can be important to get qualitative insights into these quantitative results. If more time was available, this would be a great addition to this study. It is recommended to conduct further qualitative research into the underlying differences. This can for example be done with interviews. (2) Another limitation is the high number of highly educated people in this study. The reason for this is that the survey that is used, is held under people affiliated with the Utrecht University. This study therefore does not provide a perfect picture of society as a whole. (3) Findings should also not be generalized over all countries, because the cycling culture is different in the Netherlands compared to other countries. (4) The last limitation that will be discussed is the lack of knowledge about the effect on other life domains and other time horizons as discussed in multiple studies (Chatterjee et al., 2020; De Vos & Witlox, 2017; Schimmack, 2008). This study only focusses on the time horizon ‘during the trip’. Because commuter trip satisfaction has an influence on so many other time horizons and life domains, it is important to incorporate this aspect in further research. This can be done with the help of interviews in combination with the recommendation made in the first limitation.

Recommendations for further research have been made above. There are also recommendations for practical implementation. For policy makers it can be good to focus more on the younger target group. This study found that the age of e-bikers is a lot higher than for regular cyclists. In order to maximize the benefits of the e-bike, it can be important to also target younger people who would otherwise take the car. The Utrecht University can also change their policy to enhance e-bike ridership under students. For example, they can add more facilities like charging points that are available to everyone. Don’t only have these points in the bicycle parking spaces exclusively for the staff. Another policy measure that can be taken, is contributing to the purchase of an e-bike for students who can demonstrate that they live too far away from the university to cycle and that there is no public transport near. In this way it is possible to support sustainable mobility, which Utrecht University stands for, also among students.

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Appendix

1. Significance of the independent/control variables

<u>Gender</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.320[a]	2	.115
Likelihood Ratio	4.419	2	.110
Linear-by-Linear Association	2.384	1	.123
N of Valid Cases	715		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.90.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.078	.115
	Cramer's V	.078	.115
N of Valid Cases		715	

H0 = The proportion of people who commute by e-bike is the same between all gender groups.
~~HA = The proportion of people who commute by e-bike differs between all gender groups.~~

There was no significant association between gender and commuting by regular bicycle or e-bike, X^2 (1, *N* = 715) = 4.32, *p* = .115.

The Cramer's V (0.08) shows that the effect of gender on commuting by regular bicycle or e-bike is small.

<u>Education</u>

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	47.630[a]	2	<.001
Likelihood Ratio	37.549	2	<.001
Linear-by-Linear Association	47.555	1	<.001
N of Valid Cases	715		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .70.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.258	<.001
	Cramer's V	.258	<.001
N of Valid Cases		715	

~~H0 = The proportion of people who commute by e-bike is the same between higher and lower educated.~~
HA = The proportion of people who commute by e-bike differs between higher and lower educated people.

There was a significant association between education and commuting by regular bicycle or e-bike, X^2 (1, *N* = 711) = 39.00, *p* = .001.

The Phi (0.26) shows that the effect of being a student or employee on commuting by regular bicycle or e-bike is medium.

Income

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	23.372[a]	3	<.001
Likelihood Ratio	29.749	3	<.001
Linear-by-Linear Association	16.332	1	<.001
N of Valid Cases	580		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.16.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.201	<.001
	Cramer's V	.201	<.001
N of Valid Cases		580	

~~H0 = The proportion of people who commute by e-bike is the same between different income groups.~~
HA = The proportion of people who commute by e-bike differs between different income groups.

There was a significant association between income and commuting by regular bicycle or e-bike, X^2 (1, *N* = 580) = 23.37, *p* = .001.

The Cramer's V (0.20) shows that the effect of income on commuting by regular bicycle or e-bike is small to medium.

Occupation

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	29.015[a]	1	<.001		
Continuity Correction[b]	27.701	1	<.001		
Likelihood Ratio	40.271	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	28.975	1	<.001		
N of Valid Cases	715				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 24.83.
b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.201	<.001
	Cramer's V	.201	<.001
N of Valid Cases		715	

~~H0 = The proportion of people who commute by e-bike is the same between students and employees.~~
HA = The proportion of people who commute by e-bike differs between students and employees.

There was a significant association between gender and commuting by regular bicycle or e-bike, X^2 (1, *N* = 715) = 29.02, *p* = .001.

The Phi (0.20) shows that the effect of being a student or employee on commuting by regular bicycle or e-bike is small to medium.

Travel time

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
HometoUU_min	Equal variances assumed	3.516	.061	-7.222	713	<.001	<.001	-7.657	1.060	-9.738	-5.575
	Equal variances not assumed			-6.465	163.363	<.001	<.001	-7.657	1.184	-9.995	-5.318

The independent samples t-test shows that equal variances are assumed. The difference in mean travel time for regular cyclists (*M* = 22.65; *SD* = 10.41) and e-bikers (*M* = 30.30; *SD* = 12.35) was significant (*t* (713) = -7.22; *p* < .001).

<u>Age</u>

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Age	Equal variances assumed	2.198	.139	-9.079	701	<.001	<.001	-11.180	1.231	-13.598	-8.762
	Equal variances not assumed			-9.729	191.652	<.001	<.001	-11.180	1.149	-13.447	-8.914

The independent samples t-test shows that equal variances are assumed. The difference in mean age for regular cyclists (*M* = 35.86; *SD* = 12.62) and e-bikers (*M* = 47.04; *SD* = 11.34) was significant (*t* (701) = -9.08; *p* < .001).

2. Significance of the dependent variables

General commute satisfaction

Descriptive Statistics

HometoUU_modes		N	Minimum	Maximum	Mean	Std. Deviation
Conventional bike (not e-bike)	GeneralSTS	587	-2	3	2.61	.674
	Valid N (listwise)	587				
E-bike	GeneralSTS	124	0	3	2.72	.578
	Valid N (listwise)	124				

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
GeneralSTS	Equal variances assumed	5.232	.022	-1.710	709	.044	.088	-.111	.065	-.239	.016
	Equal variances not assumed			-1.889	200.249	.030	.060	-.111	.059	-.227	.005

3. Correlation matrixes

Regular cyclists

The table below shows the correlation matrix, the means, the standard deviations, the skewness, and the kurtosis of the individual STS scores of the regular cyclists.

	1	2	3	4	5	6	7	8	9
STS1 Stressed - Calm	1								
STS2 Bored - Enthousiastic	0.33**	1							
STS3 Worked poorly - Worked well	0.38**	0.36**	1						
STS4 Tired - Alert	0.33**	0.51**	0.33**	1					
STS5 Low standard - High standard	0.34**	0.46**	0.45**	0.37**	1				
STS6 Worried - Confident	0.36**	0.26**	0.26**	0.31**	0.26**	1			
STS7 Worst imaginable - Best imaginable	0.28**	0.35**	0.40**	0.32**	0.55**	0.25**	1		
STS8 Pressed - Relaxed	0.47**	0.34**	0.29**	0.35**	0.32**	0.66**	0.34**	1	
STS9 Fed up - Engaged	0.37**	0.63**	0.38**	0.49**	0.52**	0.36**	0.47**	0.42**	1
Mean	1.85	1.06	2.16	0.96	1.29	1.74	1.34	1.37	1.19
Standard deviation	1.32	1.24	1.17	1.56	1.24	1.67	1.15	1.53	1.25
Skewness	-1.37	-0.39	-1.77	-0.51	-0.53	-1.15	-0.53	-0.75	-0.42
Kurtosis	1.37	-0.27	3.14	-0.62	-0.06	0.07	0.41	-0.46	-0.17

*Correlation matrix, means, standard deviations, skewness, and kurtosis of the STS scores of the **regular cyclists***
*** Correlation is significant at the 0.01 level*
** Correlation is significant at the 0.05 level*

E-bikers

The table below shows the correlation matrix, the means, the standard deviations, the skewness, and the kurtosis of the individual STS scores of the e-bikers.

	1	2	3	4	5	6	7	8	9
STS1 Stressed - Calm	1								
STS2 Bored - Enthousiastic	0.35**	1							
STS3 Worked poorly - Worked well	0.42**	0.41**	1						
STS4 Tired - Alert	0.23*	0.34**	0.31**	1					
STS5 Low standard - High standard	0.24**	0.49**	0.38**	0.41**	1				
STS6 Worried - Confident	0.24**	0.33**	0.26**	0.39**	0.28**	1			
STS7 Worst imaginable - Best imaginable	0.36**	0.30**	0.47**	0.30**	0.55**	0.31**	1		
STS8 Pressed - Relaxed	0.55**	0.34**	0.39**	0.40**	0.32**	0.62**	0.48**	1	
STS9 Fed up - Engaged	0.45**	0.59**	0.41**	0.51**	0.53**	0.45**	0.56**	0.50**	1
Mean	2.09	1.42	2.35	1.27	1.66	2.08	1.52	1.77	1.79
Standard deviation	1.19	1.15	0.97	1.60	1.03	1.45	1.20	1.53	1.13
Skewness	-1.74	-0.36	-1.79	-0.91	-0.36	-1.72	-0.59	-1.26	-0.84
Kurtosis	3.41	-0.41	3.59	-0.05	-0.79	2.20	0.25	0.96	0.22

Correlation matrix, means, standard deviations, skewness, and kurtosis of the STS scores of the ***e-bikers***

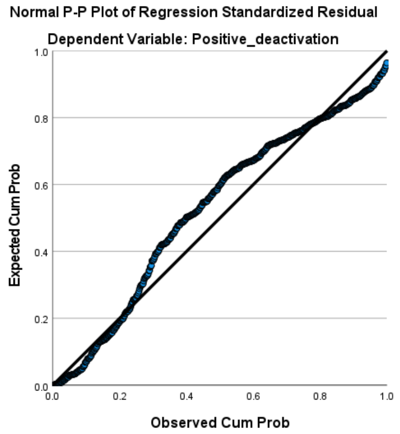
*** Correlation is significant at the 0.01 level*

** Correlation is significant at the 0.05 level*

4. Assumptions

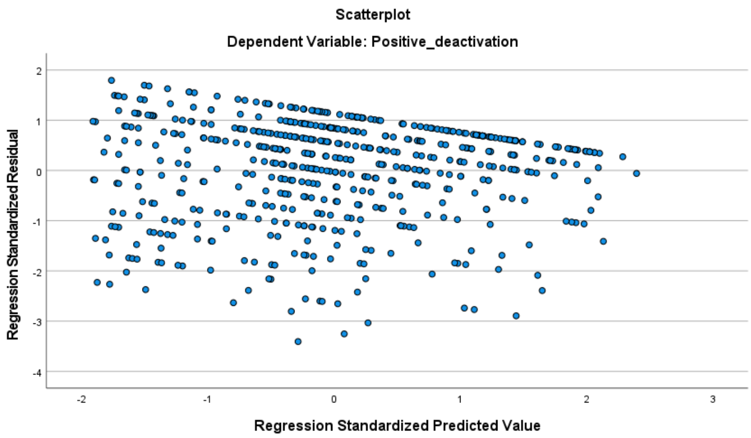
Positive deactivation

1. Normality



It can be concluded that the dependent variable 'Positive_deactivation' follows a normal distribution.

2. Homoscedasticity



It can be concluded that the dependent variable 'Positive_deactivation' is homoscedastic what is showed by the random distribution.

3. Linearity

The data is both normally distributed as well as homoscedastic, what means that linearity is not an issue in this case.

4. No multicollinearity

Coefficients[a]

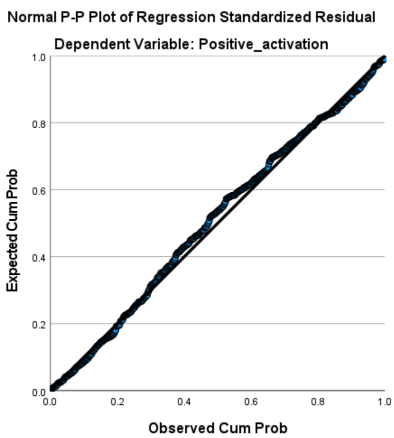
Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	.897	.329		2.728	.007		
	Income_other=< € 30.000	.115	.194	.041	.592	.554	.325	3.073
	Income_other=€ 30.001 - € 60.000	.062	.145	.024	.430	.667	.504	1.985
	Income_other=€ 60.001 - € 90.000	.221	.149	.079	1.481	.139	.553	1.810
	Gender_dummy=Male + Other	.120	.098	.048	1.214	.225	.976	1.024
	Education_other=Higher education	-.045	.175	-.011	-.259	.796	.941	1.063
	Student_Y_N=Student	-.367	.180	-.122	-2.036	.042	.433	2.307
	Age	.027	.005	.281	5.695	<.001	.638	1.567
	HometoUU_min	-.009	.005	-.081	-1.950	.052	.904	1.106
2	(Constant)	.941	.357		2.639	.009		
	Income_other=< € 30.000	.117	.194	.042	.601	.548	.325	3.075
	Income_other=€ 30.001 - € 60.000	.062	.145	.024	.428	.669	.504	1.985
	Income_other=€ 60.001 - € 90.000	.219	.150	.078	1.460	.145	.551	1.815
	Gender_dummy=Male + Other	.123	.099	.050	1.238	.216	.968	1.033
	Education_other=Higher education	-.034	.178	-.008	-.193	.847	.907	1.103
	Student_Y_N=Student	-.366	.180	-.122	-2.028	.043	.433	2.308
	Age	.026	.005	.278	5.529	<.001	.616	1.624
	HometoUU_min	-.009	.005	-.083	-1.974	.049	.889	1.124
	Mode_dummy=Conventional bike	-.048	.147	-.014	-.324	.746	.844	1.185

a. Dependent Variable: Positive_deactivation

All VIF scores are below 10 what means that there is no multicollinearity.

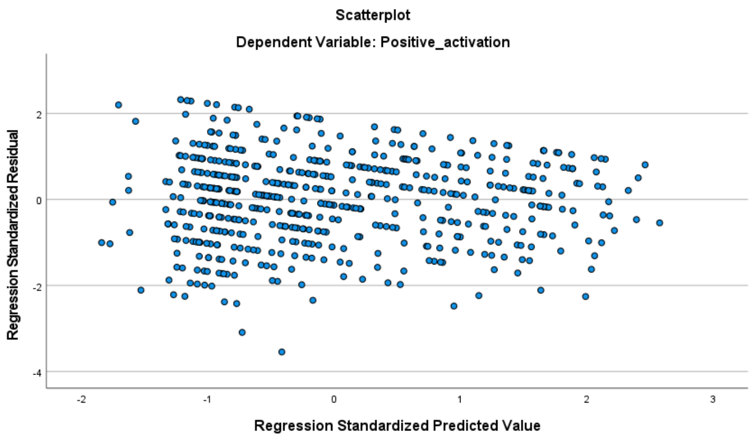
Positive activation

1. Normality



It can be concluded that the dependent variable 'Positive_activation' follows a normal distribution.

2. Homoscedasticity



It can be concluded that the dependent variable 'Positive_activation' is homoscedastic what is showed by the random distribution.

3. Linearity

The data is both normally distributed as well as homoscedastic, what means that linearity is not an issue in this case.

4. No multicollinearity

Coefficients[a]

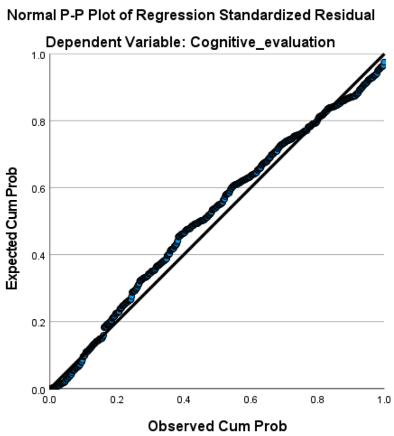
Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	.390	.293		1.329	.184		
	Income_other=< € 30.000	.031	.173	.012	.178	.859	.325	3.073
	Income_other=€ 30.001 - € 60.000	-.271	.130	-.115	-2.088	.037	.504	1.985
	Income_other=€ 60.001 - € 90.000	-.050	.133	-.020	-.379	.705	.553	1.810
	Gender_dummy=Male + Other	-.064	.088	-.029	-.726	.468	.976	1.024
	Education_other=Higher education	-.161	.156	-.041	-1.029	.304	.941	1.063
	Student_Y_N=Student	-.199	.161	-.073	-1.236	.217	.433	2.307
	Age	.029	.004	.342	7.013	<.001	.638	1.567
	HometoUU_min	-.001	.004	-.012	-.294	.769	.904	1.106
2	(Constant)	.517	.318		1.625	.105		
	Income_other=< € 30.000	.036	.173	.014	.209	.835	.325	3.075
	Income_other=€ 30.001 - € 60.000	-.271	.130	-.115	-2.092	.037	.504	1.985
	Income_other=€ 60.001 - € 90.000	-.058	.133	-.023	-.435	.663	.551	1.815
	Gender_dummy=Male + Other	-.055	.088	-.025	-.627	.531	.968	1.033
	Education_other=Higher education	-.129	.159	-.033	-.814	.416	.907	1.103
	Student_Y_N=Student	-.195	.161	-.072	-1.217	.224	.433	2.308
	Age	.029	.004	.332	6.695	<.001	.616	1.624
	HometoUU_min	-.002	.004	-.018	-.425	.671	.889	1.124
	Mode_dummy=Conventional bike	-.135	.131	-.044	-1.031	.303	.844	1.185

a. Dependent Variable: Positive_activation

All VIF scores are below 10 what means that there is no multicollinearity.

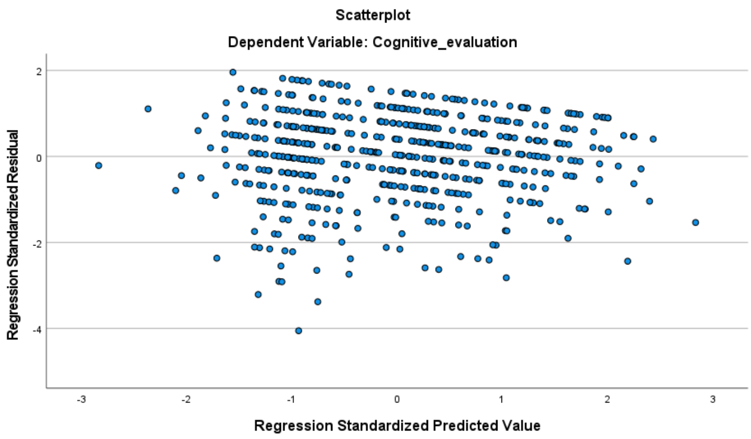
Cognitive evaluation

1. Normality



It can be concluded that the dependent variable 'Cognitive_evaluation' follows a normal distribution.

2. Homoscedasticity



It can be concluded that the dependent variable 'Cognitive_evaluation' is homoscedastic what is showed by the random distribution.

3. Linearity

The data is both normally distributed as well as homoscedastic, what means that linearity is not an issue in this case.

4. No multicollinearity

Coefficients[a]

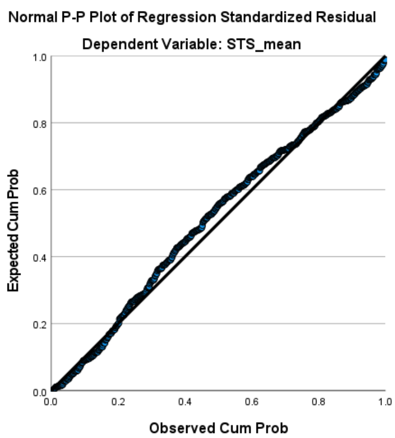
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	1.376	.263		5.233	<.001		
	Income_other=< € 30.000	-.020	.155	-.009	-.126	.900	.325	3.073
	Income_other=€ 30.001 - € 60.000	-.250	.116	-.123	-2.150	.032	.504	1.985
	Income_other=€ 60.001 - € 90.000	.042	.119	.019	.350	.726	.553	1.810
	Gender_dummy=Male + Other	.000	.079	.000	.003	.998	.976	1.024
	Education_other=Higher education	.009	.140	.003	.066	.947	.941	1.063
	Student_Y_N=Student	-.240	.144	-.103	-1.669	.096	.433	2.307
	Age	.014	.004	.193	3.814	<.001	.638	1.567
	HometoUU_min	-.007	.004	-.074	-1.746	.081	.904	1.106
2	(Constant)	1.577	.284		5.543	<.001		
	Income_other=< € 30.000	-.011	.155	-.005	-.072	.943	.325	3.075
	Income_other=€ 30.001 - € 60.000	-.251	.116	-.123	-2.163	.031	.504	1.985
	Income_other=€ 60.001 - € 90.000	.030	.119	.014	.249	.803	.551	1.815
	Gender_dummy=Male + Other	.014	.079	.007	.173	.862	.968	1.033
	Education_other=Higher education	.059	.142	.018	.413	.680	.907	1.103
	Student_Y_N=Student	-.235	.144	-.101	-1.638	.102	.433	2.308
	Age	.013	.004	.176	3.411	<.001	.616	1.624
	HometoUU_min	-.007	.004	-.084	-1.971	.049	.889	1.124
	Mode_dummy=Conventional bike	-.214	.117	-.080	-1.827	.068	.844	1.185

a. Dependent Variable: Cognitive_evaluation

All VIF scores are below 10 what means that there is no multicollinearity.

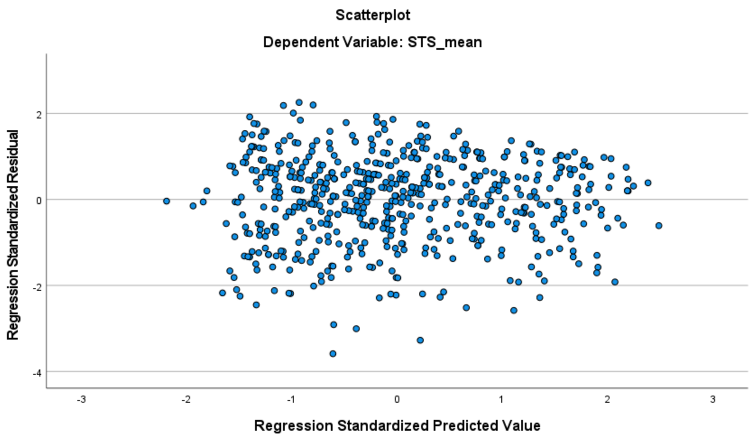
Total STS

<u>1. Normality</u>



It can be concluded that the dependent variable 'STS_mean' follows a normal distribution.

2. Homoscedasticity



It can be concluded that the dependent variable 'STS_mean' is homoscedastic what is showed by the random distribution.

3. Linearity

The data is both normally distributed as well as homoscedastic, what means that linearity is not an issue in this case.

4. No multicollinearity

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.887	.235		3.782	<.001		
	Income_other=< € 30.000	.042	.139	.021	.303	.762	.325	3.073
	Income_other=€ 30.001 - € 60.000	-.153	.104	-.080	-1.472	.142	.504	1.985
	Income_other=€ 60.001 - € 90.000	.071	.107	.034	.664	.507	.553	1.810
	Gender_dummy=Male + Other	.019	.070	.010	.266	.791	.976	1.024
	Education_other=Higher education	-.066	.125	-.021	-.525	.600	.941	1.063
	Student_Y_N=Student	-.269	.129	-.122	-2.089	.037	.433	2.307
	Age	.023	.003	.338	7.005	<.001	.638	1.567
	HometoUU_min	-.006	.003	-.068	-1.685	.093	.904	1.106
2	(Constant)	1.011	.254		3.977	<.001		
	Income_other=< € 30.000	.047	.139	.023	.341	.733	.325	3.075
	Income_other=€ 30.001 - € 60.000	-.153	.104	-.080	-1.478	.140	.504	1.985
	Income_other=€ 60.001 - € 90.000	.063	.107	.031	.594	.553	.551	1.815
	Gender_dummy=Male + Other	.027	.071	.015	.382	.702	.968	1.033
	Education_other=Higher education	-.035	.127	-.011	-.275	.783	.907	1.103
	Student_Y_N=Student	-.265	.128	-.121	-2.066	.039	.433	2.308
	Age	.023	.003	.327	6.647	<.001	.616	1.624
	HometoUU_min	-.006	.003	-.075	-1.835	.067	.889	1.124
	Mode_dummy=Conventional bike	-.132	.105	-.053	-1.263	.207	.844	1.185

a. Dependent Variable: STS_mean

All VIF scores are below 10 what means that there is no multicollinearity.

5. SPSS results multiple linear regression model without students

Model 1 Positive deactivation

Model Summary

Student_Y_N	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
						R Square Change	F Change	df1	df2	Sig. F Change
Employee	1	.285[c]	.081	.067	1.09604	.081	5.652	7	446	<.001
	2	.287[d]	.082	.066	1.09682	.001	.360	1	445	.549

a. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000

b. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

c. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000

d. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

Coefficients[a]

Student_Y_N	Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
			B	Std. Error	Beta			Tolerance	VIF
Employee	1	(Constant)	.935	.368		2.541	.011		
		Gender_dummy=Male + Other	.131	.105	.057	1.253	.211	.986	1.014
		Education_other=Higher education	-.110	.217	-.024	-.509	.611	.913	1.095
		Income_other=< € 30.000	.065	.211	.017	.306	.759	.705	1.419
		Income_other=€ 30.001 - € 60.000	.065	.143	.028	.459	.647	.553	1.809
		Income_other=€ 60.001 - € 90.000	.225	.145	.091	1.554	.121	.594	1.683
		HometoUU_min	-.006	.005	-.054	-1.159	.247	.938	1.066
		Age	.025	.005	.269	5.395	<.001	.827	1.209
	2	(Constant)	.999	.383		2.606	.009		
		Gender_dummy=Male + Other	.138	.105	.060	1.307	.192	.976	1.025
		Education_other=Higher education	-.077	.224	-.017	-.345	.731	.857	1.166
		Income_other=< € 30.000	.069	.212	.018	.324	.746	.704	1.420
		Income_other=€ 30.001 - € 60.000	.067	.143	.029	.468	.640	.553	1.810
		Income_other=€ 60.001 - € 90.000	.221	.145	.090	1.524	.128	.593	1.687
		HometoUU_min	-.006	.005	-.058	-1.230	.219	.920	1.086
		Age	.025	.005	.265	5.237	<.001	.808	1.238
		Mode_dummy=Conventional bike	-.087	.144	-.030	-.600	.549	.850	1.176

a. Dependent Variable: Positive_deactivation

Model 2 Positive activation

Model Summary

Student_Y_N	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
Employee	1	.383[c]	.147	.133	.96920	.147	10.955	7	446	<.001
	2	.387[d]	.150	.134	.96854	.003	1.602	1	445	.206

a. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000

b. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

c. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000

d. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

Coefficients[a]

Student_Y_N	Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
Employee	1	(Constant)	.196	.325		.602	.548		
		Gender_dummy=Male + Other	-.090	.093	-.043	-.975	.330	.986	1.014
		Education_other=Higher education	-.010	.192	-.002	-.053	.958	.913	1.095
		Income_other=< € 30.000	.003	.187	.001	.016	.988	.705	1.419
		Income_other=€ 30.001 - € 60.000	-.265	.126	-.123	-2.099	.036	.553	1.809
		Income_other=€ 60.001 - € 90.000	-.076	.128	-.033	-.589	.556	.594	1.683
		HometoUU_min	.001	.004	.009	.195	.845	.938	1.066
		Age	.030	.004	.351	7.289	<.001	.827	1.209
	2	(Constant)	.316	.339		.933	.351		
		Gender_dummy=Male + Other	-.078	.093	-.037	-.839	.402	.976	1.025
		Education_other=Higher education	.052	.198	.012	.262	.793	.857	1.166
		Income_other=< € 30.000	.010	.187	.003	.053	.958	.704	1.420
		Income_other=€ 30.001 - € 60.000	-.262	.126	-.122	-2.079	.038	.553	1.810
		Income_other=€ 60.001 - € 90.000	-.083	.128	-.037	-.647	.518	.593	1.687
		HometoUU_min	8.041E-5	.004	.001	.019	.985	.920	1.086
		Age	.029	.004	.341	7.015	<.001	.808	1.238
		Mode_dummy=Conventional bike	-.161	.128	-.060	-1.266	.206	.850	1.176

a. Dependent Variable: Positive_activation

Model 3 Cognitive evaluation

Model Summary

Student_Y_N	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
Employee	1	.248[c]	.062	.047	.87690	.062	4.192	7	446	<.001
	2	.267[d]	.071	.055	.87338	.010	4.609	1	445	.032

a. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000

b. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

c. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000

d. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

Coefficients[a]

Student_Y_N	Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
Employee	1	(Constant)	1.262	.294		4.290	<.001		
		Gender_dummy=Male + Other	-.018	.084	-.010	-.220	.826	.986	1.014
		Education_other=Higher education	.116	.173	.032	.671	.503	.913	1.095
		Income_other=< € 30.000	-.068	.169	-.022	-.400	.689	.705	1.419
		Income_other=€ 30.001 - € 60.000	-.255	.114	-.138	-2.233	.026	.553	1.809
		Income_other=€ 60.001 - € 90.000	.005	.116	.002	.041	.968	.594	1.683
		HometoUU_min	-.005	.004	-.060	-1.272	.204	.938	1.066
		Age	.014	.004	.194	3.845	<.001	.827	1.209
	2	(Constant)	1.446	.305		4.736	<.001		
		Gender_dummy=Male + Other	.000	.084	.000	.003	.997	.976	1.025
		Education_other=Higher education	.211	.178	.058	1.184	.237	.857	1.166
		Income_other=< € 30.000	-.057	.169	-.018	-.338	.735	.704	1.420
		Income_other=€ 30.001 - € 60.000	-.251	.114	-.136	-2.206	.028	.553	1.810
		Income_other=€ 60.001 - € 90.000	-.007	.116	-.003	-.058	.953	.593	1.687
		HometoUU_min	-.006	.004	-.074	-1.561	.119	.920	1.086
		Age	.013	.004	.177	3.488	<.001	.808	1.238
		Mode_dummy=Conventional bike	-.247	.115	-.106	-2.147	.032	.850	1.176

a. Dependent Variable: Cognitive_evaluation

Model 4 Overall STS score

Model Summary

Student_Y_N	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics R Square Change	F Change	df1	df2	Sig. F Change
Employee	1	.357[c]	.127	.114	.79016	.127	9.290	7	446	<.001
	2	.364[d]	.132	.117	.78882	.005	2.523	1	445	.113

a. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000

b. Predictors: (Constant), Age, Income_other=< € 30.000, HometoUU_min, Gender_dummy=Male + Other, Income_other=€ 60.001 - € 90.000, Education_other=Higher education, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

c. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000

d. Predictors: (Constant), Age, Income_other=€ 60.001 - € 90.000, Gender_dummy=Male + Other, HometoUU_min, Education_other=Higher education, Income_other=< € 30.000, Income_other=€ 30.001 - € 60.000, Mode_dummy=Conventional bike

Coefficients[a]

Student_Y_N	Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
Employee	1	(Constant)	.797	.265		3.008	.003		
		Gender_dummy=Male + Other	.007	.076	.004	.099	.921	.986	1.014
		Education_other=Higher education	-.001	.156	.000	-.009	.993	.913	1.095
		Income_other=< € 30.000	-7.886E-6	.152	.000	.000	1.000	.705	1.419
		Income_other=€ 30.001 - € 60.000	-.152	.103	-.088	-1.472	.142	.553	1.809
		Income_other=€ 60.001 - € 90.000	.052	.105	.028	.493	.622	.594	1.683
		HometoUU_min	-.003	.003	-.042	-.927	.355	.938	1.066
		Age	.023	.003	.335	6.897	<.001	.827	1.209
	2	(Constant)	.920	.276		3.338	<.001		
		Gender_dummy=Male + Other	.020	.076	.012	.264	.792	.976	1.025
		Education_other=Higher education	.062	.161	.018	.385	.701	.857	1.166
		Income_other=< € 30.000	.007	.152	.002	.047	.963	.704	1.420
		Income_other=€ 30.001 - € 60.000	-.149	.103	-.086	-1.448	.148	.553	1.810
		Income_other=€ 60.001 - € 90.000	.044	.105	.024	.420	.675	.593	1.687
		HometoUU_min	-.004	.004	-.052	-1.139	.255	.920	1.086
		Age	.022	.003	.324	6.586	<.001	.808	1.238
		Mode_dummy=Conventional bike	-.165	.104	-.076	-1.588	.113	.850	1.176

a. Dependent Variable: STS_mean