Bachelor Thesis

19-06-2016

Consumer adoption of Electrical Vehicles

Based on knowledge of different sorts and their relation to the environment

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Abstract

Electrical Vehicles (EV) are not yet adopted by a large public, even though they have the potential to reduce CO2 emission when adopted by them. However, not all potential users are aware of this, just as there they do not all have knowledge of different sorts of EVs (PHEV and BEV) and their impact on the environment. In this study 16 semi-structured interviews were conducted with potential users to find out how this knowledge relates to the intention to adopt EVs. This study used a persona technique. The results of this study imply that there are three personas. Namely one of them with much knowledge of EVs a positive stand towards EVs. The second persona has moderate knowledge and is more or less positive to EVs. The last one lacks knowledge on the different sorts of EVs and their relation to the environment, and therefore has no intention to adopt an EV. This concludes to two potential adopters and one non-adopter.

Samenvatting

Electrische Voertuigen (EV) zijn nog niet in gebruik bij een groot publiek terwijl ze wel de potentie hebben om CO2-uitstoot te verminderen wanneer zij wel worden aangenomen door dit publiek. Maar niet alle potentiele gebruikers zijn hiervan op de hoogte, net zoals ze ook niet altijd beseffen dat er verschillende soorten EVs zijn (PHEV en BEV) en ook niet van hun relatie tot het milieu. In deze studie zijn er 16 semigestructureerde interviews afgenomen met potentiele gebruiker om uit te vinden hoe deze kennis in relatie staat tot de intentie om EVs te gebruiken. De studie gebruikt een persona techniek. De resultaten van deze studie impliceren dat er drie personas zijn. Namelijk, een van hen heeft veel kennis van EVs en een positieve houding naar EVs. De tweede persona heeft een gemiddelde kennis en heeft een min of meer positieve houding naar EVs. De laatste persona heeft weinig kennis van de verschillende soorten EVs en hun relatie met het milieu. Deze persona heeft geen intentie om een EV te gaan gebruiken. Concluderend; er zijn twee *potential adopters* en een *non-adopter*.

Content

1. Introduction

This study focuses on consumer adoption of Electrical Vehicles (EVs). In the Netherlands, the amount of users of EVs has more than doubled over the past two years (Rijksdienst voor Ondernemend Nederland, 2016), yet this is only a small part of the total number of cars (CBS, 2015). The first goal in the coming 10 years is to increase the number of EVs in the Netherlands to about a million, because an EV has many advantages (Rijksoverheid, 2011).

However, there are also a lot of disadvantages. For people to purchase EVs, they need to accept and adopt them. This process is also called consumer adoption (Huijts, Molin, & Steg, 2012). For new sustainable energy technology acceptance, like EVs, there are several factors of influence (Huijts et al., 2012). These factors can be seen as barriers for potential users (people who have an VCE, but not any sort of EV) to buy or use an EV. One of these barriers is the relative smaller distance an EV is able to cover compared to Vehicles with a Combustion Engine (VCE). The smaller the range, the less willing potential users are to use an EV (Franke, Neumann, Bühler, Cocron, & Krems, 2012; Skippon & Garwood, 2011). Furthermore, recharging an EV consumes time and it gives people anxiety when there are not that many recharging stations around, which is one of the greatest barriers to buying an EV (Krupa et al., 2014). Another barrier concerns the limited choice in EVs. As VCE's are much more popular at the moment, there is a wider variety in cars to choose from, which makes it more alluring to buy a VCE.

Nonetheless, there are a lot of advantages of using an EV as well. One of these advantages is the absence of gas costs. Furthermore, an EV has low maintenance, which also results in lower costs. Another advantage is that EVs make less noise then VCEs. Also, to recharge your car, it is not necessary to go to a gas station. The recharging can be done at home. Another important advantage is that the EVs are environmental friendly. EVs decrease carbon dioxide (CO_2) emissions (Rezvani, Jansson, & Bodin, 2015). Furthermore, it should decrease the dependency VCEs have on fossil fuels. In the current study the focus will be more on the environment and how knowledge of it may influence one's intention to use an EV.

1.1 Different sorts of EVs

However, to be able to go further into the advantages for the environment and the knowledge individuals have of this, there first needs to be looked into the different sorts of EVs. There are different technologies within the group EVs (Rezvani et al., 2015). These include hybrid electrical vehicles (HEV), in which a normal engine is combined with an electrical system

(Schuitema, Anable, Skippon, & Kinnear, 2013). This is usually used for an effective use of fuel, which results in low usage of gas. The HEV is most similar to VCE. An advantage of the HEV is that it resolves the limited range of a full electrical vehicle as it is not reliable on electricity.

Another technology used is the plug-in hybrid electrical vehicles (PHEVs), which can be seen as the development of the HEV. It has a bigger battery, but a smaller internal combustion engine. When parked, the vehicle can be recharged by a plug-in (Sovacool & Hirsh, 2009). Its driving range varies usually between 30 and 100 km. when only using the electric battery (Denholm & Short 2006). When there is no more power, the PHEV can turn over to fuel. An extended range battery electrical vehicles (E-REVs) is an extension of the PHEV and thus has most of the same functions as a PHEV. The difference is that a longer distance can be covered using the electrical battery as the battery is lager as compared to the PHEV's battery (Rezvani et al., 2015).

The last technology that can be used is the battery electrical vehicles (BEVs). BEVs include all the electrical vehicles that only run on electricity. The battery is bigger compared to PHEVs and E-REVs and thus a longer distance can be covered. When parked, the BEVs can be recharged as well (Schuitema et al., 2013). In the current paper the term EV will be used for discussing all the vehicles mentioned in the section in general, thus all sorts of EVs.

1.2 EVs and the environment

To compare the different effects on the environment of the different sorts of EVs it is important to compare emission from well-to-wheel (WtW), which means the emission from the source to the output, as some EVs, like the BEV, drive purely on electric and therefore there is no tailpipe emission (Thiel, Perujo, & Mercier, 2010). As can be seen in figure 1 (Thiel et al., 2010), the WtW CO_2 emission is lowest with BEV. Furthermore, it gets clear that a non-electrical vehicle has a CO_2 emission between 110 and 130 g/km, while a hybrid already is less and an PHEV even less to around 60-70 g/km. However, next to well-to-wheel emission other aspects have to be taken into consideration, most of all the life-cycles of such cars (Hawkins, Gausen, & Strømman, 2012). The production of the car and the lifetime assumption should be looked into. The review by Hawkins et al. (2012)

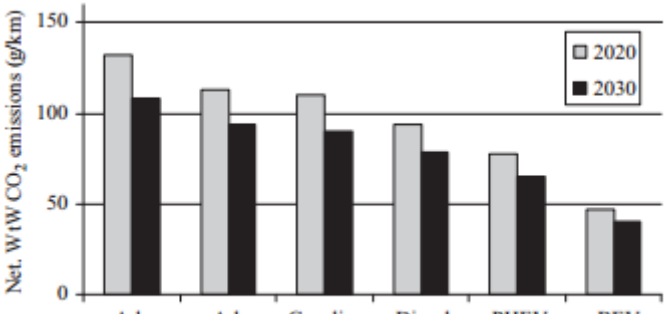

Figure 1.1: CO2 Emission with different kind of (Electrical)

presents the importance of the origin of electricity; when coming from coal, the electricity is not that clean yet. Furthermore, other aspects of the relation with the environment are looked into. It was concluded that aspects of building an EV are mostly similar to building a VCE, except for the battery (Notter et al., 2010).

Though EVs are promoted to be environmental friendly, there is a concern regarding the knowledge potential users have of this advantage (Rezvani et al., 2015). According to Graham-Rowe et al. (2012), potential users do not always feel or know the connection between EVs and the environment. Some have heard that EVs are environmental friendly, but question it because of their lack of knowledge (Graham-Rowe et al., 2012). This while EV's do have potential to reduce CO_2 emission in the future when adopted by a large public (Thiel et al., 2010). While lacking some knowledge, overall potential users do have concern for the impact cars have on the environment (Lane & Potter, 2007), even though people do differ in how important they think the environment is. There are differences in concerns people have in the environment, especially woman are more concerned with the environment compared to men (McCright & Xiao, 2014). However, though the assumption is sometimes made that socio-demographics correlate to the concern of environment, there is not a strong correlation (Franson & Gärling, 1999). There are, however, individual differences in how important people think the environment is. Therefore, more knowledge about the differences EVs and VCEs have in environmental impacts is important as this is one of the factors that is of influence of the adaptation of EVs (Achterberg, Houtman, van Bohemen, & Manevska, 2010).

Though, as mentioned before, a lot of people do not have the knowledge of the impact of EVs on the environment. However, environmental and other sorts of knowledge about new technologies are important in the consumer acceptance (Achterberg et al., 2010; Huijts et al., 2012). More knowledge influences one's intention to use a new technology, making the individual more likely to use one. Knowledge about different EVs and their impact on its environment can influence people's perception on different factors like costs, risks and benefits.

1.3 Intention to use

As indicated above, there are many advantages but certainly also barriers for buying an EV. One of the main advantages is the lower CO_2 emission with PHEV and even lower with BEV. Though, how important is that to potential users in their intention to buy an EV? According to Lane & Potter (2007) there are several factors of influence on the adoption or rejection of EVs. These factors are relative advantage (the advantage of adopting a new technology),

compatibility (the technology is in accordance with the needs and ideas of the consumer), complexity (how easy or difficult it is to use it), triability (whether it can be tried to certain limits before using it fully) and observability (how visible adopting the technology is to others). This is based on the innovation-diffusion model of Rogers. In this model there are 5 stages: the innovators (the group of people who want to have the product first), the early adopters (people who are also interested in new technologies and things, slightly later than innovators), the early majority (the first big group who is going to buy it), the late majority (the second big group, the product has been bought by the majority of people) and at last the laggards (the product is in its end phase, the last people buy it) (Rogers, 1983). In figure 2 the five different stages are shown.

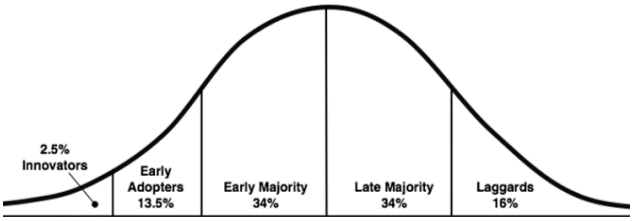

Figure 1.2: Rogers diffusion of innovation

Together with the factors that are important according to Lane & Potter (2007) and modification based on the theory of Murphy and Cohen, the model forms a framework for classifying potential users in the stages of the innovation-decision process. (Lane & Potter, 2007). In this classification there are four groups: Potential adopters (considering to buy an EV), Non-adopters (have considered but decided against buying or adopting an EV), Adopter-users (people who have an EV and are still using it) and Reject-users (people who have an EV but stopped using it). This study looks into whether the first two categories, potential adopters and non-adopters, are the only two categories that exist in people who do not have (or have used) a EV before. Furthermore, this study explores which factors contribute to being in those categories. If there are more categories, this study can give more insight into what influences those categories and what makes them more likely to use an EV.

1.4 Research goal

In this study the focus will be on PHEVs and BEVs. There will not be looked further into HEV, as these are more similar to a VCE than to an EV. Furthermore, the E-REVs are similar to the PHEV and thus will not be part of the present study.

What has become clear from the literature presented above, is that there are different sorts of EVs which are related in a positive way to the environment. However, what is also noted is that some potential users are not always aware of this, thus lack knowledge. However, research has not yet shown how this affects different potential users in their intentions to use an EV (Rezvani et al., 2015). The present study wants to contribute to the understanding of

the relation between knowledge of EVs and the environment and the usage of an EV. Therefore, the research question is stated as follows: *To what extent do potential users differ in their intention to use EVs based on their knowledge of different sorts of EVs and their relation to the environment?*

To answer this research question interviews with potential users will be held. These interviews will explore the potential user's view on EVs in general, what knowledge they have of it, what their opinion is on the environment and their knowledge of EVs and the environment. Based on the data of the interviews on these topics, persona's will be created. This will be done by using the persona's* technique of Castro, Acuña, & Juristo (2008). The created persona's will give an insight of the different potential users and their intention to use an EV based on above mentioned topics (Acuña, Castro, & Juristo, 2012).

2. Methods

2.1 Respondents

To answer the research question, 16 respondents were involved in the qualitative interviews. There were 15 Dutch respondents and 1 German respondent, who could speak Dutch. The group of respondents consisted out of 6 males and 10 females. On average they were 37 years old (SD = 17), with the youngest being 21 and the oldest 70. In total there were 7 students (of the university of Twente) varying from studying psychology to civil engineering, the other respondents were all working, varying from jobs.

The respondents were chosen based on availability sampling. The respondents knew the researchers before participating. All respondents had a car, as that was the only inclusion criteria. The diversity of the group of respondents is important for identifying different opinions on the intention to use, based on sorts of EVs and the relation to the environment.

2.2 Materials

To gather the data, a recording device, an informed consent (Appendix A) and a semi-structured interview were used (Appendix B). The interview consisted of several topics, which each had some open questions. The topics of questions are based on the theoretical overview given in the introduction and the research question. Next, these main topics of the interview will be discussed.

The interview started out with some simple demographic question (e.g. age, education), and then continued on to questions about technologies. Based on different researchers, it is important to know the opinion on technologies (Achterberg et al., 2010; Huijts et al., 2012). Respondents who are open to new technologies, and are interested in

those, should be more open to other new sustainable energy technologies; thus electrical vehicles. Next question 2 to 4, the main topic was a "normal car", asking respondents for a definition and their opinion on it. This should give an indication about the respondent's usage and liking of cars. Then question 5 about the environment followed. Based on the research, amongst others, of Lane and Potter (2007). Knowing about how important respondents find the environment is importance, since the stands towards environment might correlate to the intention to use an EV.

Question 6 started with asking about electrical vehicles, which followed trough to question 12. Those question were mainly based on the review by Rezvania et al. (2015), regarding different sorts of EV's. The interview ended with question 14-16, about the different EV's and their role in the environment, which were based mainly on research of Graham-Rowe et al. (2012) and others from section 1.2. The above mentioned questions (6-16) should give an indication of what respondents know of EVs and the relation of EVs to the environment, that should contribute to answer the research question.

This order of topics was chosen to ease respondents into the interview, starting out with topics that are more familiar, and ending with (most probably) less familiar topics. Furthermore, the order was chosen this way in order to avoid priming effect on the respondents; thus questions could not influence the respondents' later answers. Each of the topics were started off with an open question and were then followed up on with more detailed questions.

2.3 Procedure

Before the interviews took place, a pilot interview was conducted to check the interview scheme. The pilot interview was used to practice the interview and to check whether all questions were clear enough. Only slight changes were made after conducting the pilot interview. After the pilot interview, the interviews began used for the present study.

The respondents were all personal contacts of the researchers. They were approached personally by the researchers. The researcher made an appointment with the respondent, given the following information "*Would you like to participate in our research on electrical cars? It concerns a few open questions and will not take more than an hour.*" After inviting the respondent, an appointment was planned. It was up to the respondent when and where the interview took place, with the condition that it should be a quiet place where the respondent would not get distracted. The respondent chose that the interviews were conducted at the

home of the respondent or at the University of Twente. The language spoken during the interviews was Dutch

When having the interview, the respondent would first get an introduction (see Appendix B), and had to fill in the informed consent (Appendix A). Afterwards, the recording started, and the semi-structured interview was conducted, starting off with some demographics and then continuing on to several topics: Technologies, normal cars, environment, electrical cars (and the different types) and the relation of these cars to the environment. On each topic there were several main questions, followed by some sub questions that could be asked if not answered yet. When respondents would answer very shortly, follow up questions were asked. At the end of the interview, the respondent was thanked and the respondent had the opportunity to ask questions and give remarks. Furthermore, the respondent was given the chance to give their e-mail address in order to be informed on the results of the research. On average, the recorded interviews lasted 30 minutes.

2.4 Data analysis

The data was analysed by using the personas* technique by Acuña et al. (2012). They developed ten follow-up activities to create the personas. To answer the research question, only the first 6 activities have been executed.

The first activity is to state hypothesis with the first step being: 'identify possible personas' (Acuña et al., 2012). These hypotheses have been created based on expectations from the found literature and the research goal stated in section 1.3. The formed hypothesis can be found in table 2.1. The first activity also concluded 'Hold ethnographic interviews', which was done by conducting interviews with the respondents. The interviews were transcribed by using the program F4 and Microsoft Office Word.

Table 2.1

Hypothesis of persona's

	Persona hypothesis
Hypothesis 1	There is a difference in potential users in their intention to use EVs
Hypothesis 2	Potential users have different views on the environment
Hypothesis 3	Potential users have different knowledge of EVs
Hypothesis 4	Potential users have different views on new technologies
Hypothesis 5	Potential users' knowledge of different EVs and their relation to the environment should give an indication of their intention to adopt an EV

Next, the behavioural variables have to be identified, with ‘Synthesize interview responses’ and ‘List behavioural variables’. The coding of the transcribed interviews was done by Atlas.ti. This was done according to coding schema (Appendix C), based on the outcomes of the interviews and the interview schema. The coding schema consist of several variables in which potential users could differ, as can also been seen in the created hypotheses. The coding scheme consists of all topics that are needed in order to answer the research question. The variables in the coding scheme should contain a range of possible values (Acuña et al., 2012). These variables have to be compared to the personas hypotheses to validate them. The coding was done to be able to analyse the respondents.

In activity 3 the respondents were linked to behavioural variables with the first step: ‘Identify the ranges of behavioural variable values’ and second step: ‘Map interview subjects to behavioural variable values’. Based on the interviews and the coding of the interviews, respondents got assigned into a category, on each of the variables. When analysing this, the respondents could be grouped together, showing what percentage of respondents shared opinions (Appendix D). Furthermore, the respondents are grouped, showing which respondents shared an opinion together and were there was overlap (Appendix E).

In the next activity, activity 4, the significant behaviour patterns were identified. Based on the mapping of activity 3, a graphic (Appendix F) and a table (Appendix G) were created. This shows what percentage of respondents shared the different variables. From this graphic and table, the significant behaviour patterns could be identified, meaning the groups with the highest percentages.

In activity 5 the characteristics and relevant goals had to be synthesised. This resulted in the foundation of the persona’s; a personas overview (Appendix H). In the next activity, activity 6, the results thus far had to be checked for redundancy and completeness. Then followed the last activity: ‘Expand the description of attributes and behaviours’. The results of this step can be found in section 3.3, where the narratives (persona’s) were created using a persona ID.

3. Results

3.1 Observed variables

The different variables found in the interviews, according to activity 2.2, can be found in table 3.1. In this table different interview topics with their variables are shown. Each variable can be ranged on a scale of two opposite extremes (Acuña et al., 2012). This accounts for all

variables, except ‘Choice of EV’, in which the scale is not about two extremes, but rather two choices: a BEV or a PHEV.

Table 3.1

Observed categories and variables and their scale

Observed variables	**Scale**
Technologies	
Frequency of using technologies	Very often - Almost never
Opinion on technology	Very positive - Very negative
Normal car	
Frequency of using a normal car	Very often - Almost never
Knowledge of fuel consumption	Detailed knowledge - Trivial
Environment in general	
Importance of environment	Very important - Not important
Knowledge on how to improve the environment	Detailed knowledge - Trivial
Activeness in the environment	Very active - Not active
Electrical vehicles	
Knowledge of Electric vehicles in general	Detailed knowledge - Trivial
Knowledge of Different sorts electrical vehicles	Detailed knowledge - Trivial
Considering to use electrical vehicles	Considering it - Never consider it
Choice of EV	BEV - PHEV
Electrical vehicles and the environment	
Knowledge of PHEV and the environment	Detailed knowledge - Trivial
Knowledge of BEV and the environment	Detailed knowledge - Trivial
Importance of environment of choosing a car	Very important - Not important

3.2 Variable ranges

In the next section activity 3 and 4 will be discussed. On each variable, as shown in table 3.1, a definition and explanation will be given. This will be done by using quotes of the respondents (with the more important variables), which are translated from Dutch. The original quotes can be found in Appendix I.

First the respondents were ranked on each variable. These rankings were translated to a figure Based on this figure, the mapping of the respondents, (Appendix E) patterns could be found of different personas. The three personas are named Willem, Julia and Hanne. Their persona identity can be found in section 3.3. These different personas are shown in another mapping of the personas (Appendix F) and a table (Appendix G). Some variables weighed more than others in creating the variables. The variables most important in identifying a

pattern were: ‘Opinion on technology’, ‘Importance of environment’, ‘Knowledge of EVs’, ‘Knowledge of sorts’, ‘Knowledge of PHEV and the environment’ and ‘Knowledge of BEV and the environment’, as these are most important in achieving the research goal.

Variable 1 and 2: Frequency of using technologies and Opinion on technology

The ‘technology use’ and ‘opinion on technology’ variable are combined here to one explanation. The first variable, is about how often the respondents use technologies. For every persona this is very often, in other words they are using it every day. The second variable stands for what the respondents thinks of (new) technologies in general. These can be technologies such as mobile phones, laptops and more advanced technologies. Most of the respondents could name some advantages as well as disadvantages. However, Willem was more enthusiastic about new technologies and named far more advantages. Also, Willem was very interested in following new updates. Julia tended to a positive view, but could also name some disadvantages, whilst Hanne was evenly positive as negative.

“Yes, I think it is really good. Because… new technologies are in general designed in a way that they use less energy.” – Willem (respondent 2)

“Yes, it is really good but it is more for suitable for younger people, than people my age. With some things you almost need higher education to understand it, well at least I do. Still, it is good, the development is good and we are going in the right direction” – Julia (respondent 12)

“It depends, if it is really something new, that does not exist yet, then I think it is fun. However, with a new iPhone or a new phone it does not interest me that much, as my own phone is fine.” – Hanne (respondent 7)

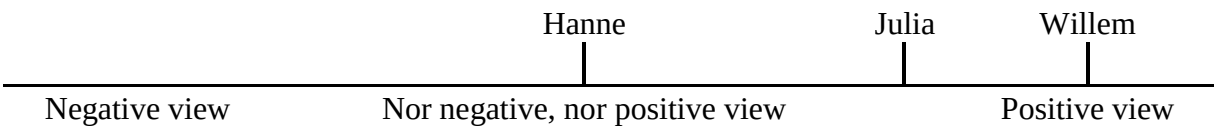

Figure 3.1: Ranging variable ‘opinion on technology’

Variable 3: Frequency of using a car

In general, most respondents use their car quite often (more than 4 times a week). For instance, Willem and Julia use their car almost every day. Using at least every weekday (to

get to work) and is usually using the car in the weekends as well to go to the supermarket or visit family and friends. Hanne uses the car a bit less. Mostly to get to and from the university, around 4 to 5 times a week.

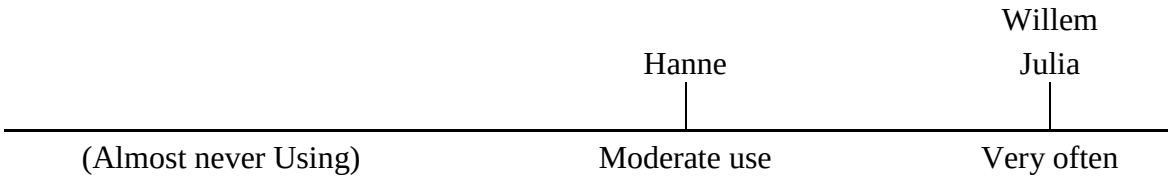

Figure 3.2: Ranging variable 'Frequency of using a car'

Variable 4: Knowledge of fuel consumption

The variable 'knowledge of fuel consumption' shows the differences in what respondents know of the fuel consumption of their own car and/or in general and how this works, for instance how to drive more economic. In this category it is not only about how much they tell about what they know (as this can be fault information) but also about how certain the respondents were about their knowledge. In this category, most respondents have moderate knowledge, which means they can tell what their consumption is, e.g. 1 on 20, but not much more than that. Julia and Hanne have moderate knowledge. Willem, however, can tell some more details about the topic, and therefore has detailed knowledge.

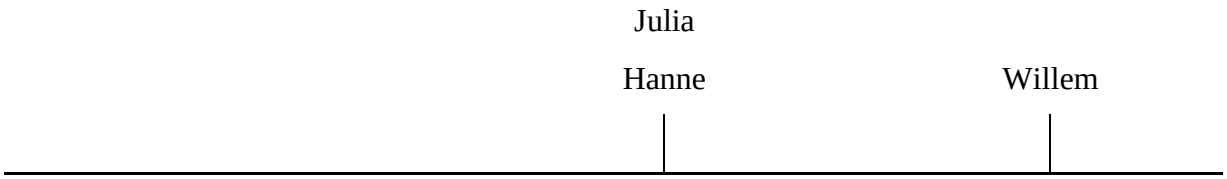

Figure 3.3: Ranging variable 'Knowledge of fuel consumption'

Variable 5: Importance of environment

The variable 'Importance of environment' is one of the main factors that was used to identify the personas. Though there was only one respondent who did not think the environment was important, there were still some differences in how important the respondents thought the environment was. Willem, for instance, announced to find the environment very important. Hanne, however, thinks its moderately important. Julia is somewhere in between the two of them, but tending a more moderate opinion.

"Well, I think the environment is quite important. Because it is not only now, but also in the

future that people have to live (…) So we have to handle it carefully." – Willem (respondent 1)

"Pfoe, hard question… One the one hand really important, but then on the other hand not at all. It has two sides for me. I sometimes think, the earth is getting worse, but then there is so much to do with environment, there are so many other problems." – Hanne (respondent 7).

"How important I think the environment is… on some moments very important and on other moments not at all haha." – Julia (respondent 16)

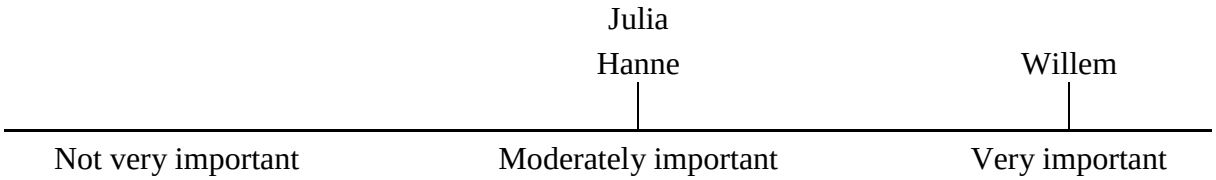

Figure 3.4: Ranging variable 'importance of environment'

Variable 6: Knowledge on how to improve the environment

This variable gives an indication at how well respondents are aware of things they could do to improve the environment. This for example could be knowing about simple things as separating trash or things like isolating the house. The range for each respondents was mainly based on how much they could name. Willem could name quite a few, ranging from moderate to detailed knowledge. Julia was aware of a lot of things that could be done, having detailed knowledge. Hanne scored on moderate knowledge, naming a few things that could improve the environment

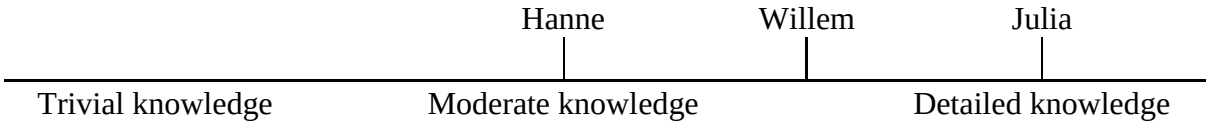

Figure 3.5: Ranging variable: 'knowledge on how to improve the environment'

Variable 7: Activeness in the environment

The variable 'Activeness in environment' ranked respondents from being not active at all to being very active in improving and protecting the environment (doing more than 4 improvements). This can also include doing bigger things, like isolating one's house. Within this range there are some big differences between the personas. Hanne, for instance, is not

active at all, doing nothing or up to one thing. Willem and Julia, however, are more active. Willem is moderately active and Julia is tending to be very active.

"No, I'm not doing anything actually. Every day I am outside surrounded by nature and I see what is going wrong there, but I do not do anything myself, no." – Hanne (respondent 11)

"We do not stoke that much (…) We remove all plugs from the sockets when we go to bed. At home we separate trash, however we don't do that here (…) And furthermore I don't think I do that much with it, except from the normal trash separating like batteries which you throw away differently. And glass things that you throw away differently, but apart from that nothing else." – Willem (respondent 5)

"I separate trash, uh…. We try to live energy efficient, making arrangements to isolate the house. I try not to accelerate like crazy to well yeah, I try to drive economically with my car. I do keep it all in mind. – Julia (respondent 9)

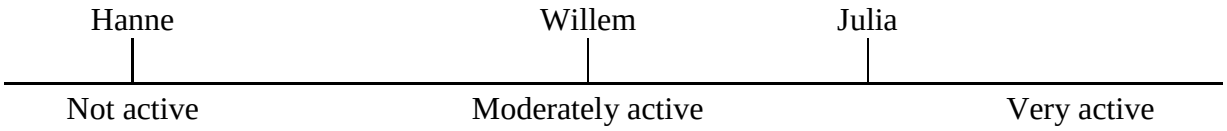

Figure 3.6: Ranging variable 'activeness in the environment'

Variable 8: Knowledge of electrical vehicles in general

The variable 'knowledge of electrical vehicles in general' gives a clear distinction between the personas. It ranges from trivial knowledge to detailed knowledge. Julia has only trivial knowledge. She can name only one thing, such as having to charge the vehicle or something about a small range of the vehicle. Hanne has moderate knowledge on EVs, as she can name some more facts about an electrical vehicle, e.g. they are very quiet. Willem has detailed knowledge on EVs. He can name those facts mentioned before and give them a detailed description. Furthermore, he is more aware about the new updates and technologies in such a car

"Well, I only know that you have to drive to those station things where you have to charge them and well, they use electricity to drive." – Julia (respondent 8)

"They are electrical. Uh… their range of how far they can drive is not that high yet and the recharging, I believe, still takes up quite some time. Also, there are not that may recharge points so that's not really favourable." – Hanne (respondent 6)

"The technology is not yet fully developed. The acquisition price it pretty high, the extent is not very high and there are some technical issues. Furthermore, there are not that many recharge points in the Netherlands (…) There are not that many types available." – Willem (respondent 2)

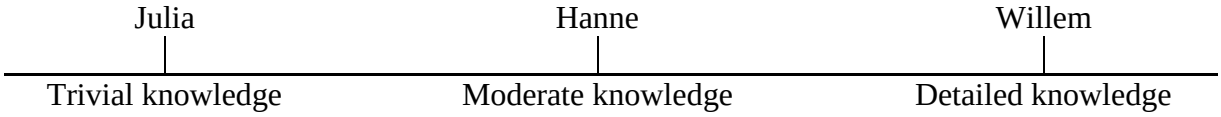

Figure 3.7: Ranging variable 'Knowledge of EVs in general'

Variable 9: Knowledge of different sorts of electrical vehicles

This variable addresses whether respondents had previous knowledge of different electrical vehicles, such as the hybrid and the battery electrical vehicles. Most of the respondents did know those two, however there was a clear distinction in what they could tell about it. Julia, for instance, had only moderate knowledge, meaning that she could tell that there were those two sorts of EVs, but no more detail than that. Hanne could tell some differences between the two and Willem could give a more detailed description about the differences.

"I believe you have mixed ones, that can also drive partly on gas and you've got fully electrical vehicles, but that's all I know" – Julia (respondent 9)

"Yes I know some are half, they run half on gas and the other half on electricity, they recharge themselves, they do not need to be recharged. And you have got the full one, that needs to be charged." – Hanne (respondent 3)

"Well, I do know the hybrid. That means that the electrical engine is used for shorter distances in the city and will switch to the electrical engine. However, when you have to drive a longer distance, then it switches automatically to use fuel, the fossil fuel that is in it. And you also got nowadays the fully electrical vehicle, which is in fact totally electrical." – Willem (respondent 1)

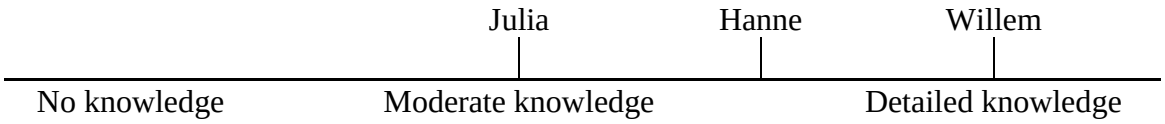

Figure 3.8: Ranging variable 'Knowledge of different sorts of EVs'

Variable 10: Considering to use EVs

The respondents varied in considering to use an EV. For instance, as Hanne is still young and in college, she does not have the means to get an EV, even though she would want an EV and certainly considered it when it is possible. Persona Julia has never really thought about buying one, and at the moment is not interested in doing so. In persona Willem a lot of inconsistency could be found, varying from never considered to considering to buy it. For this reason, it was chosen to put Willem more in the category of considering to buy a car, as this is more in line with the character.

Figure 3.8: Ranging variable 'Considering to use EVs

Variable 11: Choice of EV

In this variable, the respondents were ranked on whether they would want to drive an PHEV or an BEV, if they had to choose. Most respondents would choose a PHEV, mostly because that is a step in between to get used to a fully electrical vehicle. Furthermore, it was noted several times that the techniques thus far are not as good as were desired to be (such as range, charging points) and that the price is too high. If this would be better in the future, most would pick the BEV. As of now, tough doubting, Willem would choose a BEV. Julia and Hanne stick with a PHEV for now.

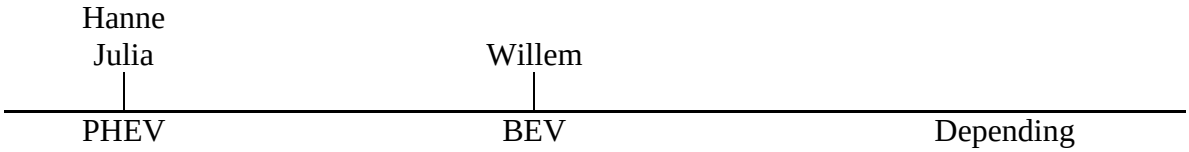

Figure 3.10: Ranging variable: 'Choice of EV'

Variable 12: Knowledge of PHEV and the environment

This variable is one of the main factors in the present study. Within the variable, some big differences can be found. Willem has most knowledge on PHEV and its relation to the environment. He can name several facts and speculate on those facts to what it means to the environment. For instance, naming that no gas emissions are good for the environment however, that depending on where the electricity comes from it would be better for the environment. Hanne, however, has trivial to moderate knowledge. She can name some things, but cannot go into detail to what kind of impact a PHEV has on the environment. Julia had no knowledge in what the PHEV means to the environment, only being able to speculate for a bit.

"In combination of, most certainly in the cities, driving on electricity is one of the big advantages. This is the reason why most of all the climate, the environment within a city is improved, because that is the place where the soot particles and the pollution are the biggest (...) The car switches to fossil fuel to often (...) Because it is a combination of an electrical vehicle and a fossil fuel car, so in that way you have the disadvantages, the pollution, direct pollution is what you get then." – Willem (respondent 1)

"Well, they are probably more economical than normal cars (...) Because they are, well, they also make use of the battery so they use less fuel than a normal car that only uses fuel. Though other than that... good for the environment." – Hanne (respondent 3)

"But in relation to environment... I wouldn't dare to say so. It probably is good, but to say that I have the idea that it is a big change, no." - Julia (respondent 16)

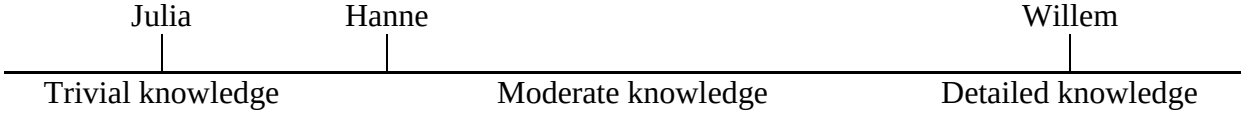

Figure 3.11: Ranging variable: 'Knowledge of PHEV and the relation to the environment'

Variable 13: Knowledge of BEV and the environment

This variable, just as the one before, is one of the main factors in the present study. This variable also consists of big differences in the range of respondents. The range variates between trivial knowledge to detailed knowledge. The results are very similar to the results of 'Knowledge of PHEV and the environment'. This can be seen as following. Willem has most

knowledge, namely detailed knowledge. Hanne is in between trivial to moderate knowledge. Finally, Julia, as in the variable before, has trivial knowledge on the topic.

"Yes it is better for the environment, I can say that with certainty. However, electricity also has to be created and when that is done by using fossil fuels than it still does not improve anything of course (…) And when we look at the newer battery packs, well yeah, they are more accessible, they can be recycled. Then you are going in the right direction of an improvement in the environment. But what happens to the battery packages that are not being used anymore? Will that still cause pollution?" – Willem (respondent 10)

"Well, you are still dealing with the shipping of the batteries, but not with the emission you would have later on (…) It is probably better for the environment. However, I think that now not that many people will do it, so in general, overall, it has little effect." – Hanne (respondent 6)

"Well, people always say that it is really good for the environment, so that is what I know, what the advantages are exactly I would not know." – Julia (respondent 13).

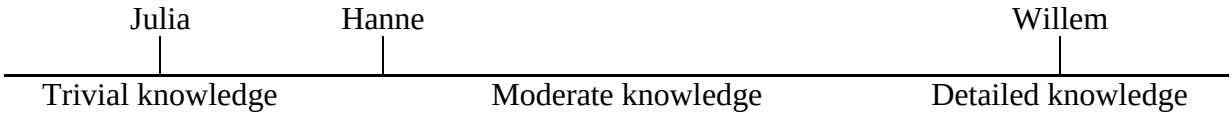

Figure 3.12: Ranging variable 'Knowledge of BEV and the relation to the environment'

Variable 14: Importance of environment in choosing a car

This variable indicates to what extend the respondents differ in how important they find the role of the environment in choosing a new car (e.g. lower fuel consumption to save the environment) and whether this would be a reason to consider buying an EV in general. For Hanne, the environment is not important in choosing a new car, for her other factors are more important, such as money. For both Willem and Julia the environment is moderately to very important in choosing a new car.

"No, not in my case. What I said before... When looking at the environment I don't think that it really matters what I do." – Hanne (respondent 15)

"When it really shows that… that the burden on the environment is a lot less then, then that could be an important reason, but then it still stands that I also think that it financially should be a concurrent with the fossil fuel engines." – Willem (respondent 1)

"Yes, when it is less of a burden to the environment" – Julia (respondent 8)

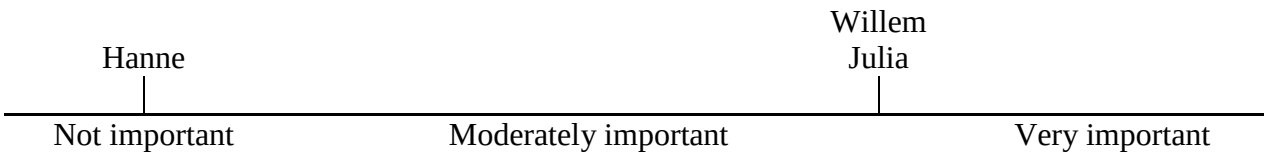

Figure 3.13: Ranging variable 'Importance of environment in choosing a car'

3.3 Personas

The next section shows the results of the seventh activity. In this sections you can find the three different personas: Willem, Julia and Hanne. Each one is shown on a Persona ID which shows their age and occupation, a quote, their biography which tells something about their opinions and the expertise on three important factors to answer the research question. These three factors are (opinion on) technology, (importance and activeness of) environment and (knowledge of) EVs. These factors represent different variables that can be found in of the observed variables in table 3.1. Next, the three persona ID cards will be presented.

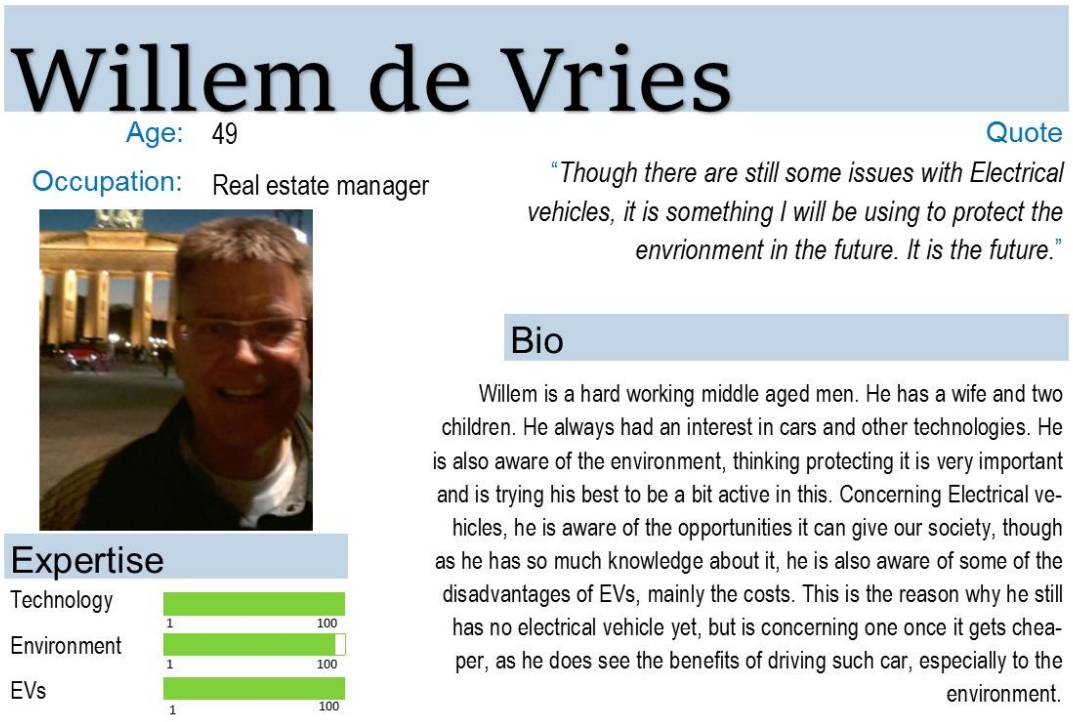

Figure 3.14: Persona Willem, based on respondents 1, 2, 5 and 10.

Hanne Kuipers

Age: 24

Occupation: Psychology student

Expertise

Technology 1 100

Environment 1 100

EVs 1 100

Quote

"I do like cars and technologies are quite allright, I am just not that ready yet for an electrical vehicle."

Bio

Hanne is a third year psychology student at the university of Twente. Though she does not mind to drive the car from time to time, and even may really like using it, she is not that much into cars. She also is not that much into technologies, except for its convenience and sometimes the nice looks. When it come to the environment she has to admit that although it might be important, she just is not active at all. When she starts thinking about electrical vehicles, there are quite some things she can name, for instance the different sorts. However, when comparing it to the environment she is not too sure what the effects are. She is not sure if the effects to the envrionment are positive at the moment. This, and the costs, are the main reasons why she is not interested in using an EV yet. This, and she thinks she might forget to recharge an EV.

Figure 3.15: Persona Hanne, based on respondents 3, 6, 7, 14 and 15.

Julia Postma

Age: 31

Occupation: Educational affairs

Expertise

Technology 1 100

Environment 1 100

EVs 1 100

Quote

"Electrical vehicles are not my cup of tea, though I do think they might be good for the environment."

Bio

Julia graduated a couple a years ago from college and is now working at a school nearby her own house. She uses the car quite often, but only for good reasons, such as driving to work. She thinks technologies are cool, though she does not know that much about them and is not that interested. She does not know that much about electrical vehicles, and certainly not about their relation to the environment. This also one of the main reasons why she never considered using or buying one. For her it is something in the future, not for now. Once proven that those cars actually make a difference in the environment and a lot of people use one, she might consider one too. For her it is most important to have a reliable car she can use, in which te costs are not too high.

Figure 3.16: Persona Julia, based on respondents 4, 8, 9, 12, 13 and 16

4. Discussion and conclusion

By doing interviews with potential users the research question, *to what extent do potential users differ in their intention to use EVs based on their knowledge of different sorts of EVs and their relation to the environment?,* should be answered. Based on the interviews personas were created which provides a better understanding of what users know about EVs (as to different kind of EVs and the relation to the environment) and their intention to use one. It became clear that there are three types of (potential) users. They differ in their willingness to use an EV and they differ greatly in their knowledge. The three types differ mostly in their willingness to use an EV. Willem is ready to use an EV, just as Hanne though she is not yet able to. Both of them know quite a lot about different sort of EVs and their relation to the environment. For persona Julia it is something for in the far future. She lacks a lot of knowledge and is not sure about all those new technologies and their role in the environment. Table 4.1 shows these personas and all their differences regarding what they think is important and what they know of EVs. These differences will be discussed below.

Table 4.1

Personas and opinions on the main factors

	Opinion on Technology	**Environment**	**Knowledge of Electrical Vehicles**	**Electrical Vehicles and the environment**
Willem	Positive	Important	Detailed	Detailed
Julia	Neutral to positive	Moderately important	Trivial	Trivial
Hanne	Nor positive, nor negative	Moderately important, not active	Moderate	Moderate

Persona Willem has a positive view on technology, thinks the environment is very important and has detailed knowledge of both EVs in general and their relation to the environment. Since Willem has a positive view on technologies and knows more about EVs and the environment, this persona is more prone to using an EV than the other personas (Huijts et al., 2012). He should be considered as one of the early adaptors (Rogers, 1983) and a potential adopter according to Lane and Potter (2007). Persona Julia is more neutral than Willem towards technology. The environment is moderately important to her and has trivial knowledge of electrical vehicles and their relation to the environment. This makes Julia less prone to using an EV. She could be placed in the group non-adopters, as she never considered using or buying an EV than Willem (Lane & Potter, 2007). Persona Hanne is most negative

towards technologies. Furthermore, she thinks the environment is moderately important but is not active at all. She has moderate knowledge of EVs and the environment. She has considered using an EV but is not ready to adopt yet. Therefore, she is not placed directly in a category by Lane & Potter (2007). However, she is open to using EVs but is not able to do this yet, as it is just not a possibility as a student. This would place her in the category potential adopters, suggesting there might be a division in this category. One group of potential adopters who are able to adopt an EV now, and one group of potential adopters who are not yet able to.

Next, the personas will be discussed comparing them to the other personas (based on hypothesis) and the found literature. They will first be discussed by 'Potential users have different views in the environment'. The results are in in line with the findings of Franson and Gärling (1999), who stated that there are individual differences in the concerns and involvement people have about the environment. Individuals who think the environment is important and are more active protecting it, are more likely to adopt new energy saving technologies such as EVs (Achterberg et al., 2010; Graham-Rowe et al., 2012). This is not entirely in line with the present study. Persona Julia, for instance, thinks the environment is moderately important and is also moderately to very active in trying to improve it. However, she has no intention to use an EV in the near future. Persona Hanne, on the contrary, is not active and does not think the environment is that important. She, however, does have the intention to use an EV. This contradicts the found literature. However, this might be due to a lack of knowledge the persona had regarding EVs; she might not feel the connection between EVs and environmental friendliness (Graham-Rowe et al., 2012).

Another hypothesis is 'Potential users have different knowledge of EVs'. As can be seen from the results, all could name some differences, however Willem knew the most and Julia knew the least. According to Huijts et al. (2012), the more knowledge individuals have of new technologies, the higher their acceptance of the technologies is. This can be found in the current research as well. For instance, Julia lacks knowledge, is less accepting and does not have the intention to use an EV. The hypothesis 'Potential users have different views on new technologies' is also confirmed. The three personas vary in having a neutral view (Hanne) to a positive view (Willem). Having a positive view on technologies correlates with being more accepting to new sustainable technologies (Achterberg et al., 2010). This is in line with the present study.

For the first hypothesis, 'There is a difference in potential users in their intention to use EVs' a clear distinction can be found too. Persona Willem is the one to adopt an EV more

easily and has a bigger intention to do so. Hanne also has interest in adopting an EV but is not able to use one yet. Julia does not have the intention to use one. This difference in intention to use can also be found in the literature, e.g. Huijts et al. (2012) and Achterberg et al. (2010), which suggests different factors are of influence on the intention to use an EV. In the current research these are knowledge of electrical vehicles and their relation to the environment.

The last hypothesis, 'Potential users' knowledge of different EVs and their relation to the environment should give an indication of their intention to adopt an EV', is also confirmed. The personas have different knowledge about the different sorts of EV and their relation to the environment, and different intensions, thus it could give an indication. However, this hypothesis could be further examined.

The current research had several strengths and weaknesses. One of those strengths was the occurrence of saturation. Saturation is the point where no new additional data can be found (Francis et al., 2010). In the present study no additional data could be found to create a new persona. At a certain point no new information was discovered, all the new participants could be placed into one of the three personas. This is a strength as there was also a lot of diversity (the group ranging from different ages and educations), meaning that there was saturation in a diverse group. This gives the saturation extra strength; even a diverse group leads to these three persona's. According to Francis et al. (2010) this adequate sample size leads to content validity.

The methodology, however, could be improved. One of the main points of improvement is that the interviews were conducted by two different interviewers. As the interview was semi-structured, the interviewers where not limited to questions on paper. This may have resulted in interviewers asking different questions that could be interpreted differently by the respondents. It was tried to make the interviews as comparable as possible, by making the scheme together and walk through the procedure together. Furthermore, the pilot interview was discussed to make the interviews as comparable as possible and get more internal reliability (Plochg & Van Zwieten, 2007).

Although the study provides new insights in people's intentions to use an EV based on knowledge and the environment, some topics remain undiscovered. One main thing is that the present study was based on what people know and their intention then to use or buy an EV. What would have been interesting is to give them information and see whether this changes their opinion. If it would not change their opinion it would be an indicator that they have no interest in EVs in the first place (which is the reason they lack knowledge). If their opinion would change, it indicates that the actual lack of knowledge influences some one's intention

of buying or using an EV. In the present study, for example persona Julia states she thinks the environment is very important, however she does not want to use an environmental friendly car yet. She also has almost no knowledge about EVs and their relation to the environment. This persona is now an anti-persona, however if she would have the information she might change her opinion, making the persona not an anti-persona anymore. This would suggest that lack of knowledge really makes a difference in intention to use. The current study cannot disclose on that as no such information was given to the participants.

Furthermore, other factors (such as barriers) could be taken into account to look at the bigger picture of personas and their intention to use an EV. The present study only focuses on some factors (knowledge and environment). Based on this, the participants expressed their opinion towards EVs. With other factors in mind, their opinion might change as more has to be taken into consideration. Though this has been done, according to Revanzi et al. (2015), this was in the form of surveys, by interviewing individuals who (had) used an EV or by mostly using early adopters. By interviewing potential adopters, as in the present study, the topic of intention to use EVs may get new insights. This study could be a starting point.

To conclude, the present study differentiated three personas which showed what factors influence the adoption of EVs. It showed two personas, although different, but willing to adopt and one (anti-) persona who was not ready to adopt an EV. The study provides insights in the relation between on the one hand adopting an EV and on the other hand the importance of the environment and the knowledge of the different EVs and the environment. These factors had influence on the intention to use of the personage, with Willem and Hanne being potential adopters and Julia a non-adopter. Furthermore, most of the findings of the personas were in line with the found literature and there upon based hypothesis. A like in technology, knowledge of sort of EVs and knowledge of their relation to the environment concluded into a higher intention to use an EV. Only more activeness and importance of environment did not lead in all personas to a higher likelihood of adopting an EV. This was not in line with the found literature. This, however, could be due to that a lack of knowledge of EVs might weight stronger than the importance of the environment. In the end, though, most found literature is in agreement with the present study. Furthermore, the used method did lead to saturation. The research question can be confirmed; there is a difference in potential users and their intention to use an EV based on knowledge of different kind of EVs and their relation to the environment. However, there are still some ways to improve the present study and gain more knowledge of the topic. This could be done by, for instance, including more factors or start off with giving the participants more knowledge on EVs.

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Appendix A: Informed consent

Toestemmingsverklaringformulier (informed consent)

Titel onderzoek: Het gebruik van elektrische auto

Verantwoordelijke onderzoeker: Liset de Bruin en Frank van der Gullik

In te vullen door de deelnemer

Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode, doel en [indien aanwezig] de risico's en belasting van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord. Ik begrijp dat film-, foto, en videomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt. Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Naam deelnemer: ……..

Datum: ……

Handtekening deelnemer: …...…….

In te vullen door de uitvoerende onderzoeker

Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam onderzoeker:

……..……..

Datum: ……

Handtekening onderzoeker: ...…….

Appendix B: Interview schema

Begin onderzoek

Hartelijk bedankt voor het mee werken aan ons onderzoek. Dit interview wordt gedaan voor mij en een andere student zijn onderzoek van psychologie aan de universiteit Twente. Zoals eerder al is aangegeven zal het over elektrische auto's gaan. Er volgen zo een aantal vragen waarin geen goed of fout antwoord is, we zijn benieuwd naar uw mening. De vragenlijst zal ongeveer 45 minuten duren. Uw gegevens zullen anoniem blijven. Daarnaast zou ik graag het interview willen opnemen. Vindt u dit goed? Bij voorbaat dank!

Heeft u nog vragen voordat we beginnen?

Ik wil graag beginnen me een aantal demografische gegevens.

Demografische gegevens:

- Leeftijd
- Opleiding
- Nationaliteit

Dan nu door naar de eerste vraag. Ik zal eerst een aantal dingen vragen over technologieën.

1. Wat voor technologieën heeft u thuis? (denk aan computers, telefoons etc. = alles wat stroom nodig heeft)
    a. Waarvoor gebruikt u deze technologieën?
    b. Gebruikt u deze vaak?
    c. Wat is het nieuwste wat u heeft?
        i. Waarom heeft u dat gekocht?
        ii. Wat vindt u ervan?
    d. Wat vindt u van nieuwe technologieën in het algemeen?

Dan gaan we nu door met vragen over auto's.

- hoeveel jaar eigen auto
- hoeveel jaar rijbewijs

2. Wat voor auto heeft u?
    a. Voor wat voor tripjes gebruikt u uw
        i. Hoe lang zijn deze tripjes?
    b. Hoe vaak gebruikt u uw auto?
    c. Wat weet u van het verbruik van deze auto?
        i. Houdt u daar rekening mee wanneer u rijdt?
    d. Wat vindt u van auto rijden?
        i. Waarom vindt u dat?

3. Wat verstaat u onder een normale auto?
    a. Wat zijn de voordelen van een normale auto voor u?
    b. Wat zijn de nadelen van een normale auto voor u?

4. Welke kenmerken van een auto zijn voor u belangrijk om een nieuwe auto te kiezen?
    Heeft u misschien nog meer eisen waaraan uw voertuig moet voldoen? (bijvoorbeeld model, kleur, snufjes, enz..)

Auto's hebben op verschillende manier met het milieu te maken. Daarom zal het volgende stukje gaan over het milieu.

5. Hoe belangrijk vindt u het milieu?
    a. Waarom vindt u dat?
    b. Wat zou u kunnen doen om het milieu te verbeteren?
    c. Wat doet u er zelf al aan om het milieu te verbeteren?
    d. Hoe actief?

Dan gaan we nu door op vragen over Electrische auto's.

6. Wat weet u van Electrische auto's?
    a. Kent u verschillende soorten elektrische auto's?
    b. Wat is volgens u het verschil hierin?

7. Heeft u wel is overwogen een elektrische auto te kopen/gebruiken?
    a. Welke EV heeft u overwogen om te kopen / gebruiken?
        i. Waarom heeft u dit toen niet gedaan?
    b. Zou u op het moment overwegen er een te kopen?
    c. Zo nee, wat zou u kunnen overhalen toch een te kopen?

Er zijn verschillende soorten EV. Een daarvan is de batterij EV, deze maakt puur en alleen gebruik van een elektrische motor die haar energie uit accu's haalt.

8. Met de focus op puur batterij EV, wat zijn daar voor u de voordelen van?
    a. En de nadelen?

U hebt net voor en nadelen aangegeven over de batterij EV en even terug in het interview over de normale auto.

9. Als u een Batterij EV en een normale auto vergelijkt, wat zijn dan voor u persoonlijk belangrijke verschillen?
    a. In hoeverre zouden deze verschillen voor u meewegen in het kiezen van een nieuwe auto?
    b. Welke auto zou u dan kiezen? Wat zou hier de belangrijkste reden voor zijn?

Dan volgen hier nog een aantal vragen over elektrisch rijden in het algemeen.

10. Denkt u dat het land waarin u woont geschikt is voor elektrisch vervoer?

11. Heeft u een idee hoe uw omgeving staat tegenover elektrisch vervoer?

12. Denkt u dat andere mensen het waarderen als u elektrisch zou rijden?

13. Zou u uzelf beter voelen als u een batterij EV zou rijden?

Naast deze Batterij EV zijn er ook andere soorten EVs. Zoals bijvoorbeeld de PHEV. Dit is een plug-in hybrid. Een plug-in hybrid is een hybride auto, hij rijdt dus zowel op elektrisch wat opgeladen kan worden en daarnaast ook op diesel/benzine

14. Wat weet u over de PHEV en hun rol in het milieu?
    a. Wanneer "niks/geen idee": Wat denkt u dat de rol zou kunnen zijn?
    b. Zou het milieu een belangrijke reden kunnen zijn om een PHEV te overwegen?
    c. Waarom wel/niet?

15. Wat weet u over een BEV en hun rol in het milieu?
    a. Wanneer "niks/geen idee": Wat denkt u dat deze rol zou kunnen zijn?

16. Is het milieu een belangrijke reden om een BEV te overwegen?
    a. Waarom wel/niet?
    b. Zijn de rollen die een BEV en PHEV spelen in het milieu volgens u verschillend? Zo ja, kunt u dit uitleggen? Zo nee, waarom is er volgens u geen verschil?
    c. Welke zou u dan kiezen?

Dan zou ik u bij deze van harte willen bedanken voor de mee werking aan ons onderzoek! hopelijk vond u het leuk?

Heeft u nog vragen?

Heeft u misschien nog op of aanmerkingen?

Zou u op de hoogte willen blijven van het onderzoek?
Indien ja: email noteren.

Dan wil ik u nogmaals hartelijk bedanken!

Appendix C: Coding Schema

Codes	Description
1. Technology Use	
1.1 Technology devices not often used	Uses it up to several times a week
1.2 Technology devices used moderately	Uses it daily
1.3 Technology devices used often.	Uses it daily, more times a day, several hours a day
2. Opinion on technology	
2.1 Negative view	Not interesting, not that useful, more negative sides
2.2 Nor positive, nor negative view	Has benefits, but also disadvantages
2.3 Positive view	Thinks its interesting and very useful
3. Usage of a normal car	
3.1 (Almost) never using	Using the car up to one time a week
3.2 Moderate use	Using the car several times a week
3.3 Very often	Daily use of the car
4. Knowledge of fuel consumption	
4.1 (Almost) none knowledge	Knows nothing to very little on the fuel consumption
4.2 Moderate knowledge	Knows the basics, e.g. 1 on 15
4.3 Detailed knowledge	Can give specific details on the cars' consumption
5. Importance of environment	
5.1 Not very important	Does not feel that it is that important
5.2 Moderately important	Important for future generations, not that much attention to it
5.3 Very important	Wants to improve it, pays a lot of attention to it
6. Knowledge on how to improve the environment	
6.1 Trivial knowledge	Can name up to two things, e.g. separating trash
6.2 Moderate knowledge	Can name up three to five things
6.3 Detailed knowledge	Can name specific details on things to do
7. Activeness in environment	
7.1 Not active	Does nothing or up to one small thing
7.2 Moderately active	Does two to four small things
7.3 Very active	Does more than four things, also trying big changes
8. Knowledge of electrical vehicles in general	
8.1 Trivial knowledge	Knows nothing to two basics
8.2 Moderate knowledge	Up to four basics, e.g. it is rechargeable, ranges are not that big
8.3 Detailed knowledge	Knows basics and details, more than 4.
9. Knowledge of different sorts of electrical vehicles	
9.1 No knowledge	Does not know different sorts of electrical vehicles
9.2 Moderate knowledge	Can name at least two different electrical vehicles

9.3 Detailed knowledge	Can name detailed differentiations between the electrical vehicles

10. considering to use an electrical vehicle

10.1 Never considered	Never thought about it
10.2 Considered using it	Has thought it trough, but not interested
10.3 Considering, not possible	Though wanting to, not a possibility at the moment
10.4 Considering to use it	Seriously contemplating to use one

11. Knowledge of PHEV and the relation to the environment

11.1 Trivial knowledge	Can name up to one thing about it
11.2 Moderate knowledge	Knows the basics, e.g. it still produces fumes
11.3 Detailed knowledge	Can give a detailed description about it

12. Knowledge of BEV and the relation to the environment

12.1 Trivial knowledge	Can name up to one thing about it
12.2 Moderate knowledge	Knows the basics, e.g. no more fumes
12.3 Detailed knowledge	Can give a detailed description about it

13. Importance of environment in buying a car

13.1 Not important	Does not play a role in buying a car
13.2 Moderately important	Important, but comes after other factors when buying a car
13.3 Important	One of the important factors amongst others

14. Choice of electrical car

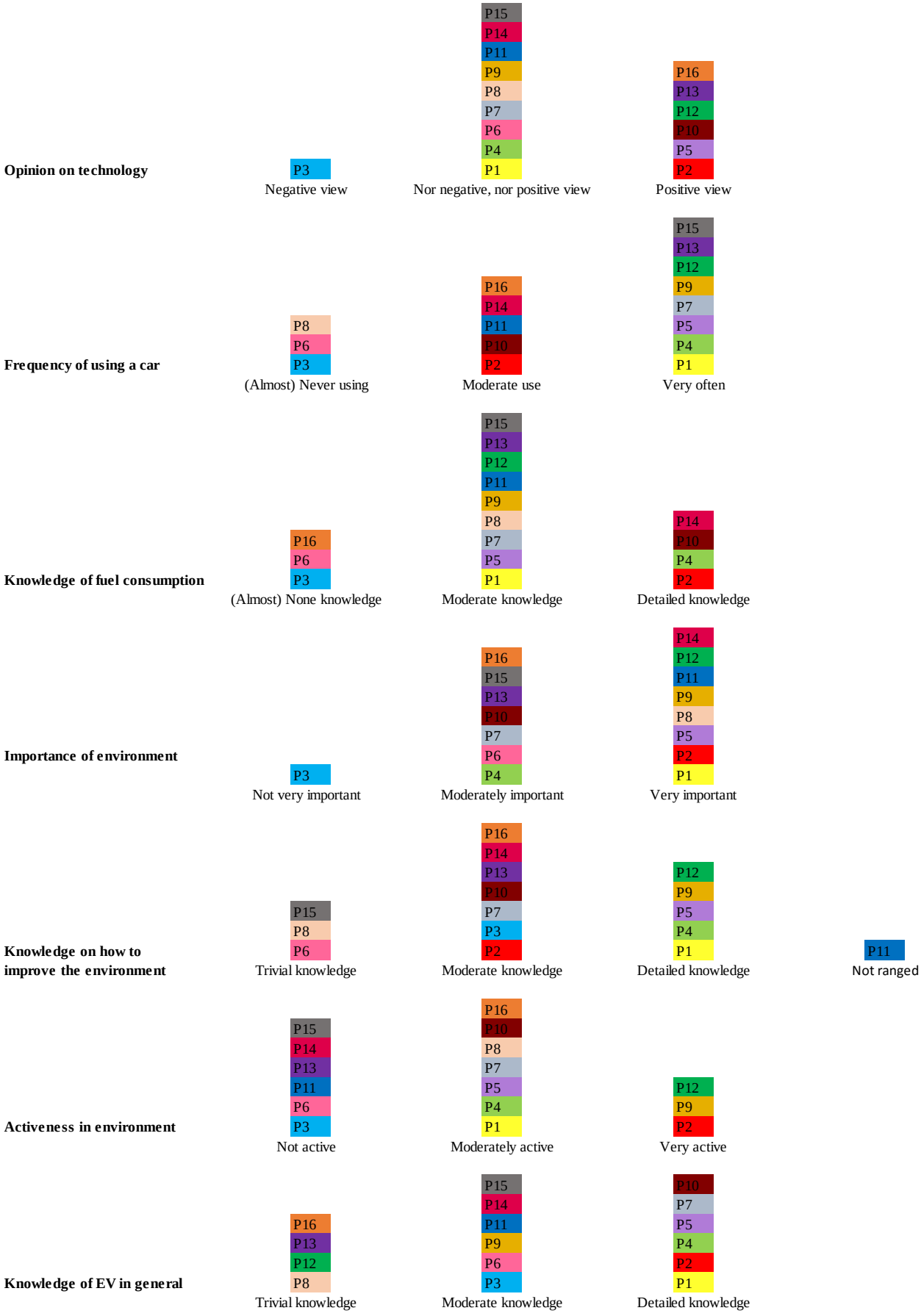
14.1 PHEV	Would choose a plug-in hybrid
14.2 BEV	Would choose a BEV
14.3 Depending	Depends on different factors, no definite choice.

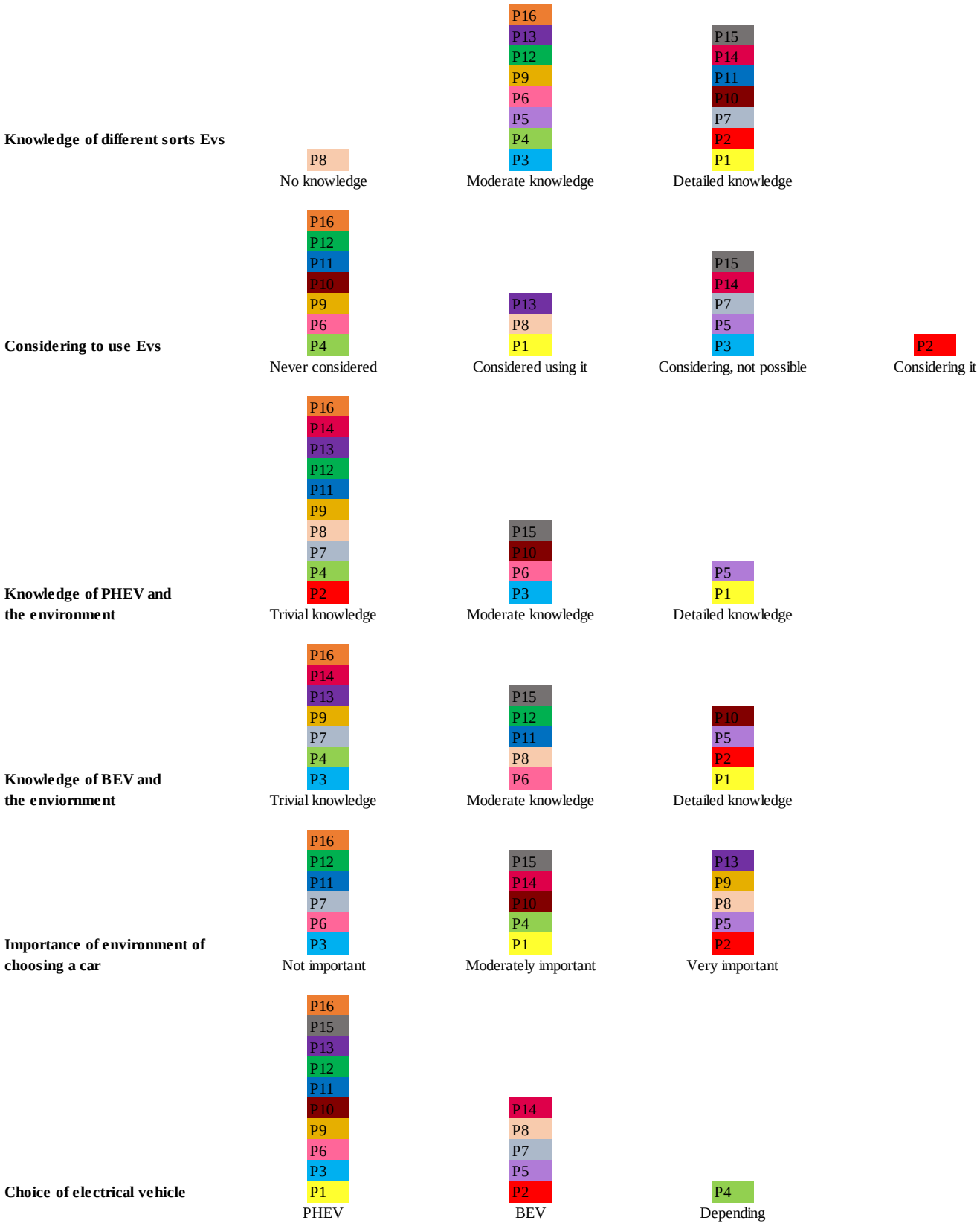
Appendix D: Percentage grouping respondents

Variable	Scale	Percentage
Technology Use	Technology devices not often used	0.0
	Technology devices used moderately	0.0
	Technology devices used often	100.0
Opinion on technology	Negative view	6.3
	Nor positive, nor negative view	50.0
	Positive view	43.8
Frequency of using a car	(Almost) never using	18.8
	Moderate use	31.3
	Very often	50.0
Knowledge of fuel consumption	(Almost) none knowledge	18.8
	Moderate knowledge	56.3
	Detailed knowledge	25.0
Importance of environment	Not very important	6.3
	Moderately important	43.8
	Very important	50.0
Knowledge on how to improve the environment	Trivial knowledge	18.8
	Moderate knowledge	43.8
	Detailed knowledge	31.3
	Not ranked	6.3
Activeness in environment	Not active	37.5
	Moderately active	43.8
	Very active	18.8
Knowledge of Electric vehicles in general	Trivial knowledge	25.0
	Moderate knowledge	37.5
	Detailed knowledge	37.5
Knowledge of different sorts electrical vehicles	No knowledge	6.3
	Moderate knowledge	50.0
	Detailed knowledge	43.8
Considering to use electrical vehicles	Never considered	43.8
	Considered using it	18.8
	Considering, not possible	31.3
	Considering to use it	6.3

Knowledge of PHEV and the environment	Trivial knowledge	62.5
	Moderate knowledge	25.0
	Detailed knowledge	12.5
Knowledge of BEV and the environment	Trivial knowledge	43.8
	Moderate knowledge	31.3
	Detailed knowledge	25.0
Importance of environment of choosing a car	Not important	37.5
	Moderately important	31.3
	Important	31.3
Choice of electrical car	PHEV	62.5
	BEV	31.3
	Depending	6.3

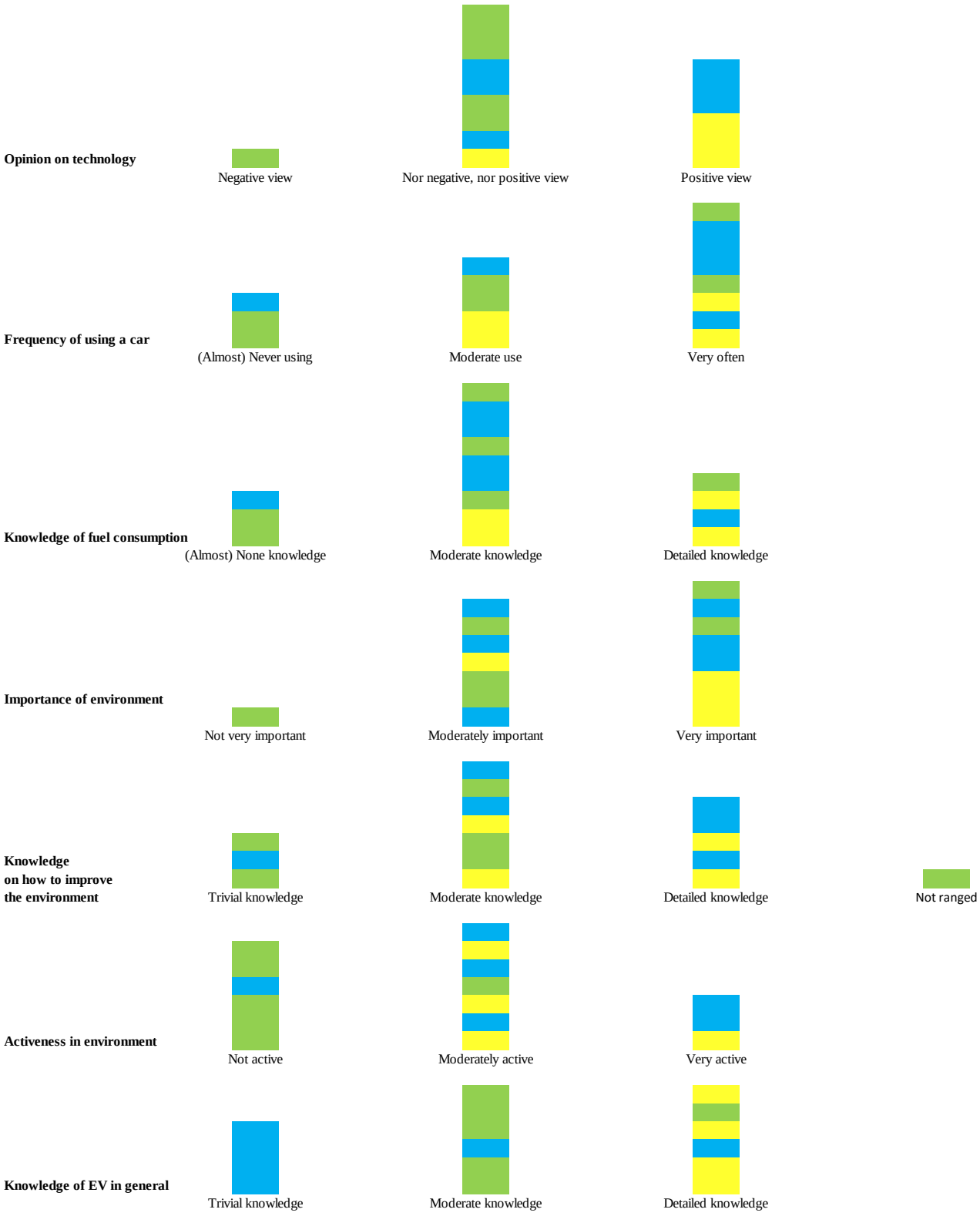
Appendix E: Mapping of respondents

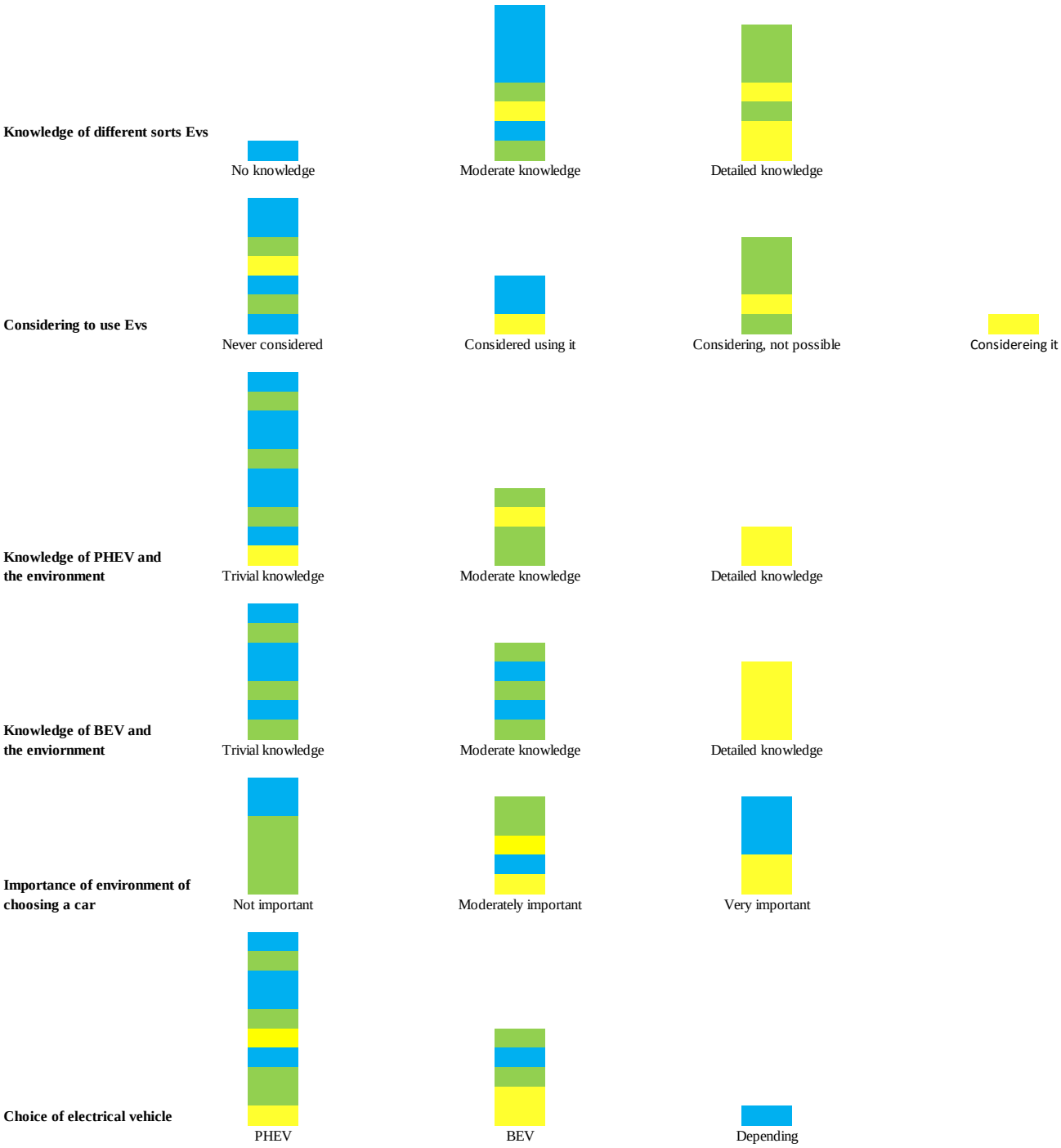



Knowledge of different sorts Evs
P8
No knowledge
P16
P13
P12
P9
P6
P5
P4
P3
Moderate knowledge
P15
P14
P11
P10
P7
P2
P1
Detailed knowledge
Considering to use Evs
P16
P12
P11
P10
P9
P6
P4
Never considered
P13
P8
P1
Considered using it
P15
P14
P7
P5
P3
Considering, not possible
P2
Considering it
Knowledge of PHEV and the environment
P16
P14
P13
P12
P11
P9
P8
P7
P4
P2
Trivial knowledge
P15
P10
P6
P3
Moderate knowledge
P5
P1
Detailed knowledge
Knowledge of BEV and the enviornment
P16
P14
P13
P9
P7
P4
P3
Trivial knowledge
P15
P12
P11
P8
P6
Moderate knowledge
P10
P5
P2
P1
Detailed knowledge
Importance of environment of choosing a car
P16
P12
P11
P7
P6
P3
Not important
P15
P14
P10
P4
P1
Moderately important
P13
P9
P8
P5
P2
Very important
Choice of electrical vehicle
P16
P15
P13
P12
P11
P10
P9
P6
P3
P1
PHEV
P14
P8
P7
P5
P2
BEV
P4
Depending

Appendix F: Different personas on variables

Yellow: Julia – Blue: Willem – Green: Hanne




Knowledge of different sorts Evs
No knowledge
Moderate knowledge
Detailed knowledge
Considering to use Evs
Never considered
Considered using it
Considering, not possible
Considereing it
Knowledge of PHEV and the environment
Trivial knowledge
Moderate knowledge
Detailed knowledge
Knowledge of BEV and the enviornment
Trivial knowledge
Moderate knowledge
Detailed knowledge
Importance of environment of choosing a car
Not important
Moderately important
Very important
Choice of electrical vehicle
PHEV
BEV
Depending

Appendix G: Differences between and within personas

Variable	Scale	Willem	Julia	Hanne
Frequency of using technologies	Technology devices not often used	0	0	0
	Technology devices used moderately	0	0	0
	Technology devices used often	1	1	1
Opinion on technology	Negative view	0	0	0.17
	Nor positive, nor negative view	0.25	0.50	0.83
	Positive view	0.75	0.50	0
Frequency of using a car	(Almost) never using	0	0.17	0.33
	Moderate use	0.50	0.17	0.33
	Very often	0.50	0.67	0.33
Knowledge of fuel consumption	(Almost) none knowledge	0	0.17	0.33
	Moderate knowledge	0.50	0.67	0.50
	Detailed knowledge	0.50	0.17	0.17
Importance of environment	Not very important	0	0	0.17
	Moderately important	0.25	0.50	0.50
	Very important	0.75	0.50	0.33
Knowledge on how to improve the environment	Trivial knowledge	0	0.17	0.33
	Moderate knowledge	0.50	0.33	0.50
	Detailed knowledge	0.50	0.50	0
	Not ranked	0	0	0.17
Activeness in environment	Not active	0	0.17	0.83
	Moderately active	0.75	0.50	0.17
	Very active	0.25	0.33	0
Knowledge of Electric vehicles in general	Trivial knowledge	0	0.67	0
	Moderate knowledge	0	0.17	0.83
	Detailed knowledge	1	0.17	0.17
Knowledge of different sorts electrical vehicles	No knowledge	0	0.17	0
	Moderate knowledge	0.25	0.83	0.33
	Detailed knowledge	0.75	0	0.67
Considering to use an electrical vehicle	Never considered	0.25	0.67	0.33
	Considered using it	0.25	0.33	0
	Considering, not possible	0.25	0	0.67
	Considering to use it	0.25	0	0
Knowledge of PHEV and the environment	Trivial knowledge	0.25	1	0.50

	Moderate knowledge	0.25	0	0.50
	Detailed knowledge	0.50	0	0
Knowledge of BEV and the environment	Trivial knowledge	0	0.67	0.50
	Moderate knowledge	0	0.33	0.50
	Detailed knowledge	1	0	0
Importance of environment of choosing a car	Not important	0	0.33	0.67
	Moderately important	0.50	0.17	0.33
	Important	0.50	0.15	0
Choice of electrical car	PHEV	0.50	0.67	0.67
	BEV	0.50	0.17	0.33
	Depending	0	0.17	0

Appendix H: Personas overview

Persona 1: Willem

- Based on respondents 1, 2, 5 and 10 (N=4).
- Gender: 3 males, 1 female.
- Age: ranging from 24 to 70 (M=49, SD=18.99)
- Nationality: Dutch
- Positive view on technology.
- Using the car moderately to very often (from 4 days a week to daily).
- Moderate to detailed knowledge on fuel consumption.
- The environment is very important.
- Moderate to detailed knowledge on how to improve the environment.
- Moderately active in improving the environment.
- Detailed knowledge on EVs.
- Detailed knowledge on different sort of EVs.
- Considering or considered to use or buy an EV.
- Moderate to detailed knowledge on the PHEV and the relation to the environment.
- Detailed knowledge on the BEV and the relation to the environment.
- The environment is moderately to very important in choosing a new car.
- Mixed choice between PHEV and BEV

Persona 2: Julia

- Based on respondents 4, 8, 9, 12, 13 and 16 (N=6)
- Gender: 6 females
- Age: ranging from 21 to 58 (M=36, SD=16.17)
- Nationality: 5 Dutch, 1 German
- More positive than negative view on technology
- Using the car moderately to very often
- Moderate knowledge on fuel consumption
- The environment is moderately to very important
- Moderate to detailed knowledge on the how to improve the environment
- Moderately to very active in improving the environment
- Trivial knowledge on EVs
- Moderate knowledge on different sort of EVs
- Never considered to use or buy an EV.
- Trivial knowledge on the PHEV and the relation to the environment
- Trivial knowledge on the BEV and the relation to the environment
- The environment is moderately important in buying a new car

- Choice would be an PHEV.

Persona 3: Hanne

- Based on respondents 3, 6, 7, 11, 14 and 15 (N=6)
- Gender: 3 males, 3 females
- Age: ranging from 21 to 61 (M= 28, SD=15.46)
- Nationality: 6 Dutch
- Nor negative, nor positive view on technology
- Using the Car moderately
- None to moderate knowledge on fuel consumption
- The environment is moderately important
- Trivial to moderate knowledge on how to improve the environment
- Not active in improving the environment
- Moderate knowledge on EVs
- Detailed knowledge on different sorts of EVs
- Is considering to buy an EV, but not possible at the moment
- Trivial to moderate knowledge on the PHEV and the relation to the environment
- Trivial to moderate knowledge on the BEV and the relation to the environment
- The environment is not important in buying a new car
- Choice would be an PHEV.

Appendix I: Translation quotes

Variable	Orignal quote	Translation
1 + 2	Het ligt eraan, als het echt iets heel erg nieuws is, dat gewoon nog niet bestaat, dan vind ik het wel heel leuk. Maar een nieuwe iPhone of een nieuwe telefoon ofzo dat boeit me niet zo heel veel want die van mij is prima.	It depends, if it is really something new, that does not exist yet, then I think it is fun. However, with a new iPhone or a new phone it does not interest me that much, as my own phone is fine.
	Ja harstikke goed maar het is meer voor de jongeren onder ons dan voor, dan dat het voor deze leeftijdsgroep is, want bij sommige dingen heb je zowat hogeschool nodig voor dat je het snapt, ik tenminste. Maar ja het is goed, de ontwikkeling is goed en eh je gaat toch die kant op.	Yes, it is really good but it is more for suitable for younger people, than people my age. With some things you almost need higher education to understand it, well at least I do. Still, it is good, the development is good and we are going in the right direction.
	Ja dat vind ik heel goed. Want uh… nieuwe technologieën zijn in het algemeen erop ingericht dat ze minder energie verbruiken.	Yes, I think it is really good. Because… new technologies are in general designed in a way that they use less energy.
5	Nou, ik vind milieu opzich wel belangrijk. Want het is nu alleen nu, maar ook naar de toekomst dat mensen moeten kunnen leven (…) Dus daar moeten we wel zorgvuldig mee om gaan.	Well, I think the environment is quite important. Because it is not only now, but also in the future that people have to live (…) So we have to handle it carefully.
	Hoe belangrijk vind ik het milieu... op sommige momenten heel belangrijk en op andere momenten weer niet haha.	How important I think the environment is… on some moments very important and on other moments not at all haha.
	Pfoe lastig vraag, ja opzich wel heel erg belangrijk maar ook weer totaal niet. Het heeft voor mij ook echt twee kanten. Ik denk soms van de wereld gaat echt naar de klote, maar soms ook van al dat gedoe met het milieu, er zijn zo veel andere problemen.	Pfoe, hard question… One the one hand really important, but then on the other hand not at all. It has two sides for me. I sometimes think, the earth is getting worse, but then there is so much to do with environment, there are so many other problems.
7	We stoken niet zo veel (…) We trekken alle stekkers uit de stopcontacten als we gaan slapen. Thuis doen we aan afvalscheiding en hier niet (…) En verder denk ik dat ik er persoonlijk niet veel aan doe, afgezien van ja wel de normale afvalscheidingen en batterijen die gooi je anders weg en glaswerk die gooi je anders weg, maar afgezien daar van niet.	We do not stoke that much (…) We remove all plugs from the sockets when we go to bed. At home we separate trash, however we don't do that here (…) And furthermore I don't think I do that much with it, except from the normal trash separating like batteries which you throw away differently. And glass things that you throw away differently, but apart from that nothing else.
	Ik doe aan afval scheiden uh… we proberen energiezuinig te leven, maatregelen nemen om de woning te isoleren. Ik probeer niet als een gek op te trekken om een nou ja toch proberen zuinig met mijn auto te rijden. Ik hou er zeker wel rekening mee. (...)	I separate trash, uh…. We try to live energy efficient, making arrangements to isolate the house. I try not to accelerate like crazy to well yeah, I try to drive economically with my car. I do keep it all in mind. (…)
	Nee ik doen er eigenlijk niks aan. Ik ben alle dagen in de natuur en ik zien ook wat er fout gaat in de natuur, maar er zelf iets aan doen, nee.	No, I'm not doing anything actually. Every day I am outside surrounded by nature and I see what is going wrong there, but I do not do anything myself, no.
8	Dat de technologie nog niet helemaal uitontwikkeld is. Dat de aanschaf van de elektrische auto's nog vrij hoog zijn, dat de actieradius niet zo groot is en er zijn toch nog technisch wel wat problemen en het aantal	The technology is not yet fully developed. The acquisition price it pretty high, the extent is not very high and there are some technical issues. Furthermore, there are not that many

	oplaadpunten is nog niet zo hoog in Nederland (…) Er zijn nog niet zo veel types beschikbaar.	recharge points in the Netherlands (…) There are not that many types available.
	Ze zijn elektrisch. Uh… dat hun range van hoe ver ze kunnen rijden nog niet heel hoog is en dat opladen volgens mij ook nog best wel lang duurt, en er zijn ook niet zo veel oplaadpunten dus dat is niet zo heel erg gunstig.	They are electrical. Uh… their range of how far they can drive is not that high yet and the recharging, I believe, still takes up quite some time. Also, there are not that may recharge points so that's not really favourable.
	Nou ik weet alleen dat je altijd naar die stations dingen moet en ze op moet laden en dat ze ja stroom gewoon rijden.	Well, I only know that you have to drive to those station things where you have to charge them and well, they use electricity to drive.
9	Nou, ik ken in principe de hybride. Dat betekent dat een elektrische motor die voor korte stukken in de stad en in principe overgeschakeld op de elektrische motor maar op het moment dat er grotere lange afstand gereden wordt, dan schakelt die automatisch over op na ja de brandstof, de fossiele brandstof die erin zit. En je hebt tegenwoordig ook de volledige elektrische auto's, die feitelijk helemaal.	Well, I do know the hybrid. That means that the electrical engine is used for shorter distances in the city and will switch to the electrical engine. However, when you have to drive a longer distance, then it switches automatically to use fuel, the fossil fuel that is in it. And you also got nowadays the fully electrical vehicle, which is in fact totally electrical.
	Je hebt volgens mij gemengde, die ook nog voor een deel benzine kunnen en je hebt hele elektrische auto's maar verder weet ik er niet zo veel van.	I believe you have mixed ones, that can also drive partly on gas and you've got fully electrical vehicles, but that's all I know.
	Ja ik weet dat sommige zijn half, die lopen ook half op benzine en half op stroom, die laden zichzelf op, die hoeven niet opgeladen te worden. En dan heb je de volledige die wel opgeladen moet worden.	Yes, I know some are half, they run half on gas and the other half on electricity, they recharge themselves, they do not need to be recharged. And you have got the full one, that needs to be charged.
12	In combinatie van, zeer zeker in de steden, het rijden op elektrisch dat een van de grote voordelen is. Waardoor met name het, het klimaat, milieu binnen een stad in ieder geval ook beter is, want daar is met name de roetdeeltjes en de vervuiling wel heel erg groot (…) Dat toch nog te vaak de auto snel over gaat op fossiele brandstof. (…) Want het is een combinatie van een elektrische auto en van een fossiele brandstof auto dus in die zin heb je de nadelen van een fossiele brandstof, die verontreinig, direct verontreiniging oplevert heb je dan.	In combination of, most certainly in the cities, driving on electricity is one of the big advantages. This is the reason why most of all the climate, the environment within a city is improved, because that is the place where the soot particles and the pollution are the biggest (…) The car switches to fossil fuel to often (…) Because it is a combination of a electrical vehicle and a fossil fuel car, so in that way you have the disadvantages, the pollution, direct pollution is what you get then.
	Maar qua milieu... Ik durf het niet zo goed te zeggen. Het zal vast goed zijn, maar om nou te zeggen dat ik het idee heb dat het wereldveranderend is, nee.	But in relation to environment… I wouldn't dare to say so. It probably is good, but to say that I have the idea that it is a big change, no.
	Nou ze zullen waarschijnlijk zuiniger zijn dan gewone auto's (…) Omdat ze maar, zeg maar ze rijden ook op batterij dus ze gebruiken minder brandstof dan een gewone auto die volledig op brandstof rijdt. Maar waar ze verder… goed voor zijn voor het milieu.	Well, they are probably more economical than normal cars (…) Because they are, well, they also make use of the battery so they use less fuel than a normal car that only uses fuel. Though other than that… good for the environment.
13	Ja het is beter voor het milieu dat is een ding wat zeker is. Alhoewel stroom moet ook opgewekt worden en als je stroom opwekt met fossiele brandstoffen dan schiet je er niet veel mee op natuurlijk. (…) En als we gaan	Yes it is better for the environment, I can say that with certainty. However, electricity aslo has to be created and when that is done by using fossil fuels than it still does not improve anything of course (…) And when

	kijken naar de wat nieuwere accupacks dat zijn ja die zijn vaak nog heel bereikbaar, te recyclen en dan ga je aardig in de richting van een beter milieu maar wat gebeurd er met de afgeschreven accupakketen van een elektrische auto?	we look at the newer battery packs, well yeah, they are more accessible, they can be recycled. Then you are going in the right direction of an improvement in the environment. But what happens to the battery packages that are not being used anymore?
	Nou mensen zeggen altijd dat het heel goed is voor het milieu, dus dat is wat ik weet, wat precies de voordelen zijn durf ik niet te zeggen.	Well, people always say that it is really good for the environment, so that is what I know, what the advantages are exactly I would not know.
	Nou je zit alsnog met die verscheping van batterijen, maar niet meer met de uitstoot die je daarna zou uitstoten. (…) Het is waarschijnlijk wel veel beter voor het milieu. Maar ik denk dat tot nu toe weinig mensen het zullen doen dus over het algemeen, globaal gezien het weinig effect heeft	Well, you are still dealing with the shipping of the batteries, but not with the emission you would have later on (…) It is probably better for the environment. However, I think that now not that many people will do it, so in general, overall, it has little effect.
14	Als daadwerkelijk aantoonbaar zo is dat uh… die milieubelasting daarop een stuk minder is, dan zou dat wel een belangrijke reden kunnen zijn maar dan nog geldt nog altijd een tweede denk ik en dat is dat het ook financieel een concurrent moet zijn met de fossiele brandstof motoren.	When it really shows that… that the burden on the environment is a lot less then, then that could be an important reason, but then it still stand that I also think that it financially should be a concurrent with the fossil fuel engines.
	Ja, als die minder milieu belastend is.	Yes, when it is less of a burden to the environment.
	Nee voor mij niet. Wat ik eerder ook al zei… met het oog op milieu denk ik niet dat het veel uitmaakt wat ik doe.	No, not in my case. What I said before... When looking at the environment I don't think that it really matters what I do.