rijksuniversiteit groningen

BACHELOR THESIS

Exploring behavioural spillovers between the mobility and household domains in Groningen

Abstract

Climate change is happening. Therefore, an energy transition is on our hands. Technological advancements, together with a policy-making paradigm shift are needed. The concept of behavioural spillovers between different sustainability domains is used as a tool for policy-makers to accommodate the energy transition. Self-Perception theory, Balance theory and Dissonance theory provide a rationale for behavioural spillovers. Quantitative analysis is used to analyze data sampled via a questionnaire taken in two neighborhoods of the city of Groningen: Reitdiep and Oosterparkwijk. Descriptive statistics point out slight differences in the spatial distribution of sustainability activities. Further analysis found a minor positive spillover between the mobility and household domains, suggesting that an increased behaviour in one can lead to an increased behaviour in the other. This is explained by consistency and identity effects. A lack of spillover effects is explained by decision modes.

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1. Introduction

1.1 Background

''Imagine a giant asteroid on a direct collision course with Earth. That is the equivalent of what we face now.''

- James Hansen (2012), climatologist, on climate change

Sustainability might be one of the biggest issues mankind currently faces. Sustainability can be defined as 'the capability of being sustained'. It entails the quality of not being harmful to the environment. Many things in modern society however, are not capable of being sustained. The transport sector for instance, is not maintainable in terms of emissions and air quality (Chapman, 2007). For the past two decades, but especially since the signing of the Paris Agreement in 2016, building a sustainable way of providing energy for our homes and companies has become a top priority for the world's leaders. In that endeavor, mobility and transportation are key players. Personal vehicles using combustion engines are still the most popular mode of transportation in the Netherlands (Rijkswaterstaat, 2017). On the other hand, as figure one shows, alternative modes of transportation are growing in numbers in Amsterdam.

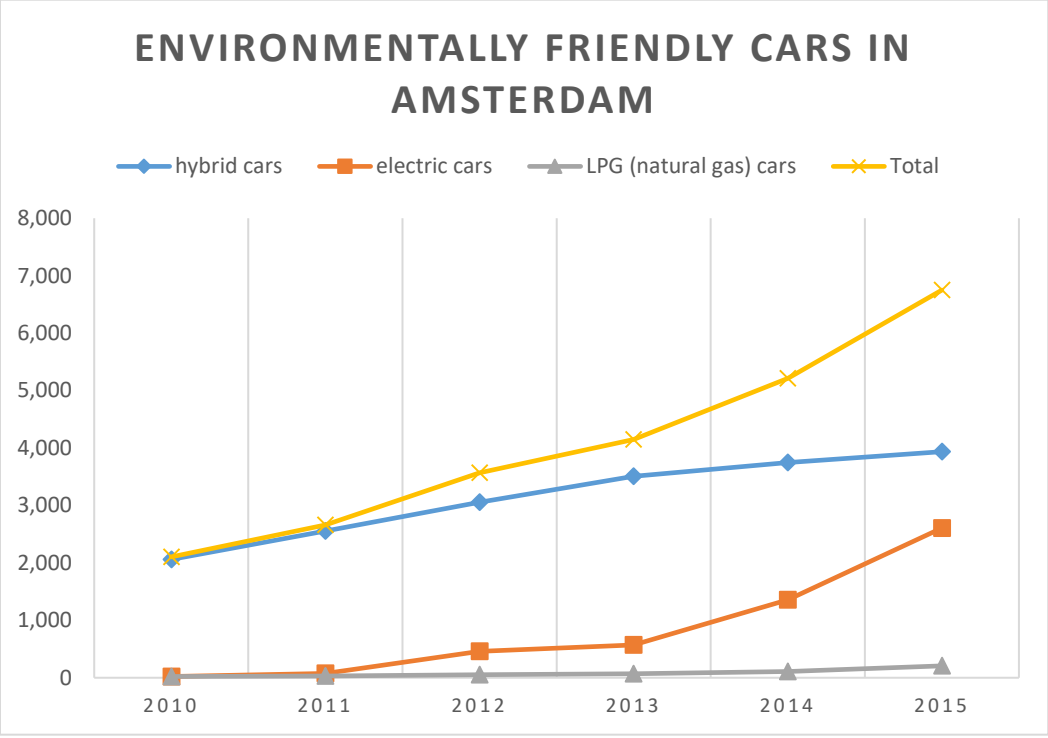

Figure 1 Environmentally friendly cars in Amsterdam (source: Amsterdamse Thermometer Bereikbaarheid 2016)

As Chapman (2007) describes, the transport sector alone is responsible for 26 percent of global CO2 emissions. In addition, it is one of the few sectors where growth in emissions is observed. A shift towards a greener transport sector is therefore needed. At the same time, spillovers of environment-friendly consumer behaviour are researched. For example, if a person behaves environment-friendly in

one domain, does this effort also spill over into other domains? It has been shown that some sustainable behaviour indeed makes one more likely to behave in the same manner in other domains (Thogersen & Ölander, 2003). This is called a positive spillover. However, this applies the other way around as well (Thorgersen, 1999). This is called a negative spillover. The link between sustainable behaviour around the house and in mobility however, is something which is yet to be clarified in the Netherlands. A data gap is observed. The aim of this research is therefore to add to the understanding about the concept of behavioural spillovers.

1.2 Research problem

The problem can be described as follows. First, it is established that climate change is happening. Second, it is argued (transport) policy and technological innovations are key to tackle this problem. Third, the concept of behavioural spillovers is introduced as a tool for policy-makers. The existence of a positive spillover effect between domains prove to be a valuable tool for policy makers. Therefore, the existence of this effect in the city of Groningen will be tested in this study. This research aims to explore the concept of behavioural spillover effects between the mobility and household domains in the city of Groningen. In addition, it tries to find a positive spillover effect between the mobility and household domain in two neighborhoods of the city of Groningen. Consequently, the problem - a lack of knowledge on this specific topic – can be resolved.

1.2.1 Central question and secondary questions

The central question of this research is: to what extent does a relation exist between sustainable behaviour in mobility and sustainable behavior in households among residents of the city of Groningen in 2017?

This main question will be answered by testing several hypotheses. Each question aims to find a certain spillover. Sustainable mobility for example has more than one aspect. Multiple aspects of both the mobility and household domains are tested against each other.

Secondary questions:

1. To what extent is there a relation between the ownership of (more) sustainable vehicles and the number of sustainability activities performed per household?
2. To what extent is there a relation between the ownership of (more) sustainable vehicles and the way people rate certain sustainable activities?
3. To what extent is there a relation between modes of transportation most used and the number of sustainability activities performed per household?
4. To what extent is there a relation between energy labels of cars and energy labels of houses?
5. To what extent is there a relation between age and the amount of sustainable activities performed per household?

1.2.2 Hypotheses

Based on the theoretical framework (chapter two), the following hypothesis have been formulated for each of the secondary questions independently.

1. H0= In the population, no relation exists between the ownership of (more) sustainable vehicles and the number of sustainability activities performed per household. H1= A (more) sustainable vehicle leads to a higher total amount of sustainability activities performed per household.
2. H0= In the population, no relation exists between the ownership of (more) sustainable vehicles and the mean sustainability score. H1= A (more) sustainable vehicle leads to a positive spillover towards the mean sustainability score.
3. H0= In the population, no relation exists between modes of transportations most used and the number of sustainability activities performed per household. H1= The higher the usage of (more) sustainable modes of transportation, the more sustainability activities are performed per household.
4. H0= In the population, no relation exists between energy labels of cars and energy labels of houses. H1= The higher the label of the one, the higher the label of the other.
5. H0= In the population, no relation exists between mean age and the mean amount of sustainability activities performed per household. H1= A higher mean age leads to a higher amount of sustainability activities per household.

The H1 hypotheses, naturally, were that relations did in fact exist in all five cases. It was expected to find relations in all five questions. However, it was hypothesized that questions one, four and five were most likely to produce interesting results based on the theoretical framework (chapter two).

1.3 Structure

First, a theoretical framework is portrayed in chapter two. Existing literature on the topic of behavioural spillovers is reviewed. The current paradigm is also reflected upon. Second, the methodology behind filling a data gap is explained and defended in chapter three. Third, the results of this research are specified and discussed in relation to the theoretical framework in chapter four. Fourth, conclusions are drawn based on these results in chapter five, after which recommendations will be made. Finally, the appendices are included beneath the concluding chapter.

2. Theoretical framework

Defining spillovers

First, definitions of relevant terms to this research should be given. The term spillover entails an influence of an intervention on behaviour not pursued by the intervention (Truelove, et al., 2014). An intervention can be defined as any effort to promote behavioural change. This might entail a monetary incentive or a public education campaign.

A spillover can be both positive and negative. A positive spillover is when an increased amount of pro-environmental behaviour in one domain is related to an increased amount of pro-environmental behaviour in another domain. A negative spillover on the other hand is when an increased amount of pro-environmental behaviour in one domain is related to a decreased amount of pro-environmental behaviour in another domain (Thorgersen & Crompton, 2009). Evidence for the existence of both types of spillover is provided later.

Finally, definitions of other relevant concepts should be made. First, the concept of human mobility can be defined as the movement of people from place to place. Second, the concept of sustainability can be defined as simply the ability to be sustained in terms of both the natural and built environment. Additionally, sustainability can be defined more specifically in environmental science: the quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance (Morelli, 2011). Third, governance can be defined as the rules, processes and behavior that affect how governing is exercised (Finka & Kluvankova, 2015).

Negative spillovers

Several studies provide evidence for the existence of negative spillovers. A study by Thørgersen (1999) found that negative spillovers did exist. For example, a negative effect existed between recycling and personal norms about waste prevention of packaging. Also, it is not confirmed that performing sustainable activities leads to more predictive behaviour within the realm of sustainability. A research on sustainability relevant vacation decisions found that the most 'sustainable' person at home often makes the least sustainable decisions on vacation in terms of emissions, destinations and modes of transportation (Barr, et al., 2010). This delivers some evidence of a negative spillover. Interestingly, this outcome also introduces a geographical component since, evidently, location does have some effect on pro-environmental behaviour. On a side note, an article by Homsy and Warner (2015) explores what type of governance is required to boost sustainable initiatives in cities through multi-level analysis. They state spatial differences in sustainability policy implementations between suburbs and inner cities can be observed (Homsy & Warner, 2015). These two articles provide evidence for spatial differences in pro-environmental behaviour.

Furthermore, a 'buy-in' effect was observed in a recent study by Jacobsen et al. (2012). Participants had the opportunity to buy different amounts of 'green' electricity. The group that bought the least expensive amount of 'green' energy subsequently showed higher energy consumption (a negative spillover effect) while other groups that bought more 'green' electricity showed no significant changes in behaviour. A positive spillover was therefore not observed (Jacobsen, et al., 2012). Negative spillover effects can to some extent be explained by moral cleansing theory (Sachdeva, et al., 2009). This theory states that an increase in 'morally wrong' (i.e. non-sustainable) behaviour results in a more pro-environmental behaviour pattern to compensate for the 'bad' behaviour (Truelove, et al., 2014). It should be noted non-sustainable behaviour does not necessarily equate 'morally wrong' behaviour. However, moral cleansing theory alone is not enough to explain the entire negative spillover.

For example, further research suggests negative spillovers can be explained by a moral licensing effect (Thorgersen & Crompton, 2009). This effect entails the need to steer one's moral self-image in a certain

direction. Moral licensing in terms of pro-environmental behaviour is the reduced likelihood of performing a moral action after completing one. The completed behaviour 'justifies' the reduction in sustainability behaviour.

Positive spillovers

A popular article by Whitmarsh and O'Neill (2010) explores the relation between sustainable actions and spill-over effects. They found a pro-environmental self-identity is a strong predictor of pro-environmental behavior. An interesting finding was that personal importance of climate change together with number of children per household are significant factors. Different demographical backgrounds proved to influence which specific sustainable activities are conducted. This provides the basis on which this thesis is built. If indeed a 'green' mentality exists in the minds of residents, does this mentality show signs of spilling over into other domains? Spill-over effects may prove to be a useful tool for policy-makers to create a shift in focus from fossil fuels to renewables. In line with this, it is shown a paradigm shift in mobility policy-making is indeed needed (Banister, 2008).

Several studies found evidence of positive spillovers. For example, a correlation was found between recycling and waste reduction (Thorgersen, 1999). In addition, relations were also found between recycling and several other activities across domains: water usage reduction, energy conservation and reduction of plastic bag usage (Berger, 1997). Other studies suggested that the probability of conducting one activity positively relates to the probability of conducting another activity within a sustainability domain (i.e. energy conservation), as well as between different domains (Whitmarsh & O'Neill, 2010) (Bratt, 1999).

Furthermore, Spence et al. (2014) argue that environmental awareness might play an important role. In their research, participants were made aware of their footprint in terms of emissions. The study found that because of this awareness, a higher chance of broader sustainable actions was created. This hints at a positive spillover effect. The study also points out a 'sustainability' mindset.

Spillover: consistency and identity

The previous indicates two factors might explain behavioural spillovers: consistency and identity (Truelove, et al., 2014). The first factor, consistency, is explained as the human desire to be consistent in terms of behaviour to maintain one's values and beliefs over time. This is derived from Self-Perception theory and Balance Theory, among others. Self-Perception theory, formulated by Bem in 1972, states that sustainable behaviour in one area could change a person's attitude and self-image. Consequently, preparedness towards other sustainable actions increases. Self-Perception theory states people built their attitudes by observing their own actions and subsequently assessing what attitude could be the cause of said actions (Bem, 1972). The human desire towards consistency is also explained by Balance Theory, as proposed by Heider (Heider, 2013). Balance Theory is a theory of attitudinal change. It is a conceptualization of the urge to be consistent as a motivation towards psychological balance (Eagly & Chaiken, 1993). In other words, the urge for psychological balance nudges people towards more consistent behaviour patterns. Consistent behaviour is also performed out of fear of being recognized as hypocritical. Social sanctions therefore, among others, are motivators behind the consistency effect.

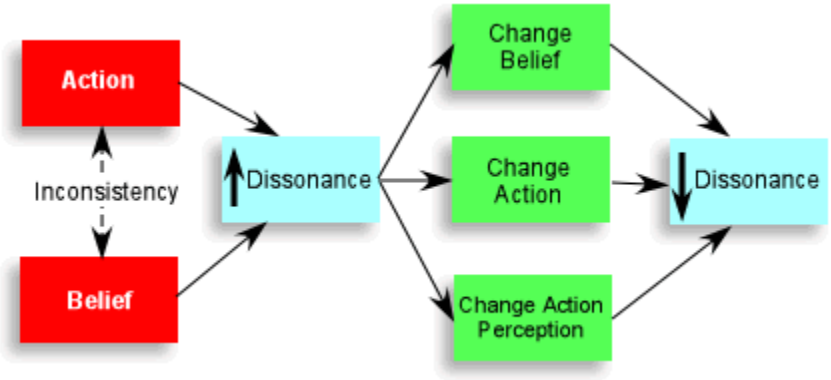

Figure 2: Cognitive Dissonance Theory visualized (Ganser, 2016)

The second factor, identity (or social identity), is explained as the section of a person's self-perception that is established by membership in a group of people (Truelove, et al., 2014). This also applies to the domains of sustainability. For example, a study found an individual's identity as a pro-environmentalist affected pro-environmental behaviour (Whitmarsh & O'Neill, 2010). Dissonance theory (Festinger, 1962) states unpleasant tension is observed in a person after witnessing facts or opinions contradicting said person's own opinion, norms and values (Eagly & Chaiken, 1993). This theory can be used to explain the role of (social) identity in behaviour, since beliefs and opinions are large parts of our identities (Whitmarsh & O'Neill, 2010). A visual representation of Dissonance Theory is provided above in figure two (Ganser, 2016). In conclusion, both the consistency effect and identity effect can be used to explain behavioural spillovers.

However, the absence of a spillover effect is also possible. Truelove et al. (2014) show different ways of deciding to participate in sustainability behaviour: calculation based, negative affect based and role based. The first is a decision made from careful consideration and determining pros and cons. It is argued that behaviour following such a decision leads to no net spillover because the second behaviour in the other domain might be more difficult or inconvenient, resulting in no further change in behaviour. The article by Truelove et al. (2014) also presents three elements key to whether people perform more, less or equal amounts of sustainable behaviour. The first element is the decision-mode one uses to initially start pro-environmental behaviour. The second element is the attribution people provide for said behaviour. The third element is the characteristic of the behaviour themselves.

2.1 Conceptual model

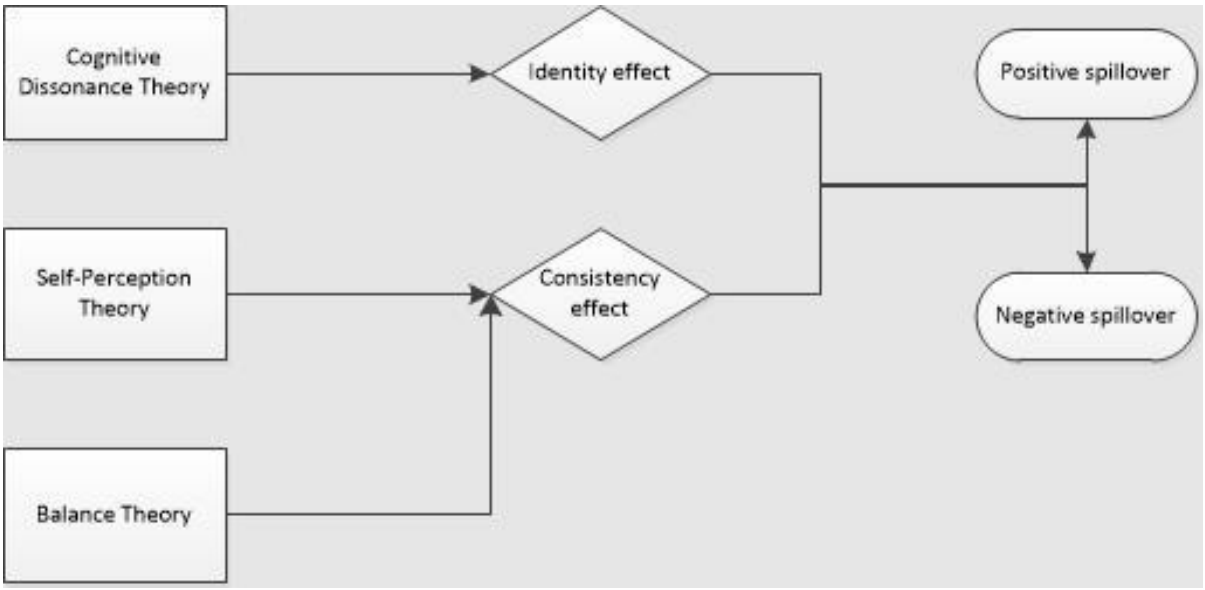

Figure 3: Conceptual Model of a theoretical framework for behavioural spillovers (source: personal interpretation)

The model above (Figure 3) is used in this thesis to explain which concepts and theories are central to the framework necessary to answering the central questions. A brief explanation of the model follows.

Self-Perception Theory (Bem, 1972) and Balance Theory (Heider, 2013) both (partially) provide evidence for the existence of a consistency effect. Cognitive Dissonance Theory (Festinger, 1962) (partially) provides evidence for the existence of an identity effect. Both these effects influence behaviour. When applied to environmental science, both effects can be used to explain environmental behaviour. Namely, whether a spillover effect occurs and if so, whether it is a positive or a negative spillover effect. This research aims to test this model in two neighborhoods in the City of Groningen.

3. Methodology

This research was conducted using quantitative methodology. The quantitative approach accommodates bigger datasets, factual measurements and can provide reliable predictions or conclusions for large populations (Moore & McCabe, 2006). Spillover effects in economic geography for example, are measured numerically. Because of these characteristics, a quantitative approach to this research problem has been chosen. This means primary data was collected (Clifford, et al., 2010). This method is briefly explained. A data collection instrument – a questionnaire – has been provided (see appendix 1) and explained. Finally, ethical considerations have been made.
Sustainable vehicles in this research refer to vehicles that use a propulsion system (partly) other than the regular internal combustion engine. This means hybrid cars, electric cars, hydrogen cars, gas powered cars. Public transport and cycling will also be counted as sustainable mobility because it has more sustainable characteristics than normal car use.
Other sustainability activities in the household might entail: actively bringing down both energy consumption and pollution (smart cv, LED lights, isolation, lowering plastic bag usage, recycling, sustainable mobility, re-use, little packaging stores). Also, actively harvesting green energy (windmills, solar panels, cold/warmth storage, geothermal heating and blue batteries) is considered to be sustainability activity. These definitions are formulated because one of the questions in the questionnaire is meant to count the amount of sustainability activities per household.

3.1 Explanation of questionnaire and sampling

Based on the Gemeentelijke Duurzaamheidsindex (Duizend Duurzame Daden, 2017) and the Klimaatmonitor (ABF Research, 2015) from the Dutch Government, a region considered leading in both sustainable mobility and sustainable housing has been selected. This region is the city of Groningen. This region was chosen because its leading position in sustainability supports the assumption that sustainable action is important for Groningen. Therefore, further improvements are likely to be made. The outcome of this research could influence the way this is done.

Questionnaire and analysis

The questionnaire is provided in the appendix (see appendix 1) at the end of this thesis. This method of data collection was chosen because it is an independent way of conducting a sample which is as random as possible. Thus, the sample was as representative for both neighborhoods as possible. This data collection instrument was used to provide sample data from one of the most sustainable municipalities concerning mobility and housing. The questionnaire was completely anonymous. Respondents were asked to answer a series of yes or no questions concerning sustainability activities. This resulted in a binary variable. This data was later aggregated into the total amount of sustainability activities performed. In addition, respondents were asked to answer what type of car they owned (if any). This resulted in a nominal variable. Furthermore, respondents were asked to rank a set of modes of transportation. This resulted in an ordinal variable. Finally, respondents were asked to rate certain statements concerning sustainability. This rating explains the respondent's standpoint concerning these variables which were too hard to measure using a yes or no framework. This rating resulted into a numeric variable, which was aggregated into a total score. By means of this, factors of sustainability which were hard to measure have been incorporated. Respondents were also asked for the energy labels of both their homes and their cars. These ordinal variables gave insight into possible spillovers.

Sampling

Two samples have been taken for this research. The first sample was taken among residents of the Reitdiep neighborhood in Groningen. The second sample was taken among residents of an older neighborhood: Oosterparkwijk. These neighborhoods have been chosen because of their unique characteristics. Reitdiep for example is a neighborhood best described as a Dutch suburb. It is relatively young in terms of age and is therefore constructed with modern needs in mind. The second neighborhood, Oosterparkwijk, is a much older and centralized neighborhood. It differs greatly from Reitdiep in terms of demographics, income and building style. This difference is the reason it is selected. Spillovers might or might not occur for several reasons, this choice of different neighborhoods incorporates these reasons into the research. Also, the Oosterparkwijk has seen renovations over the past decade. This means older sections were either restored or demolished and replaced with new and therefore often more sustainable homes. This creates an interesting dynamic within the neighborhood with on the one hand the older parts and on the other hand the newer parts. In the table below (table: comparison of characteristics), certain characteristics of both neighborhoods are summarized. Note that Oosterparkwijk is a lot denser in terms of addresses per squared kilometers. Also, Oosterparkwijk residents rarely own their house. Interestingly, average electricity usage is higher for the newer neighborhood Reitdiep.

Comparison of characteristics (CBS, Statline, 2015)

	Reitdiep	**Oosterparkwijk**
Number of residents (total)	2595	11680
Income (mean, in euro's)	41500	22000
Type of residence	11% rented, 89% owned	96% rented, 4% owned
Average residence value (in euro's)	265000	125000
Density (in addresses per squared kilometer)	748	3729
Car ownership (total)	1070	3045
Average total electricity usage (in kWh)	3310	2020

In the first sample, respondents were selected using a multi-stage sample. Out of a list of area codes in Reitdiep, a set of area codes was randomly picked. The questionnaire was distributed among randomly chosen streets. After a street is identified, a random number generator provides a number to complete the address. This method of data collection ensured the most random and un-biased selection of cases. The actual data collection has been done by going door to door. Every address without residential function was left out of the sample. A total of sixty respondents were gathered for this first sample. The area in which the sample was taken, is portrayed in the figure below in the darker brown color to the top left (Figure 4).

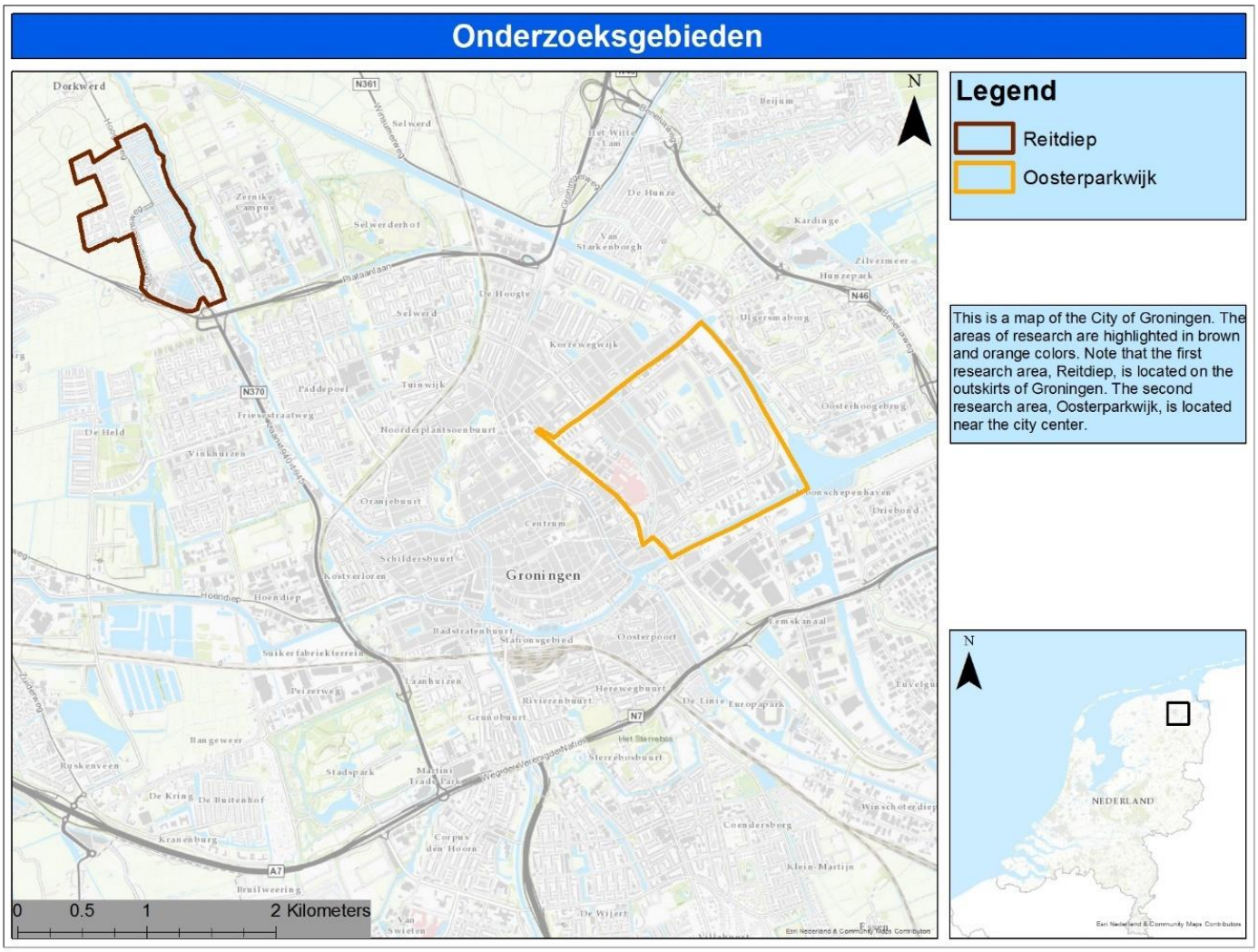

Figure 4: An overview of the research areas (ArcGIS)

In the second sample, respondents were also picked using a multi-stage sample. Out of a list of area codes in the Oosterparkwijk, a set of area codes was randomly picked. The questionnaire was distributed among randomly chosen streets in this area. After a street was identified, a random number generator provided a number to complete the address. The actual data collection has been done by going door to door. Every address without residential function was left out of the sample. A total of fifty-one respondents have been gathered. An overview of the research area is portrayed in the figure above (Figure 4). The second sample is the lighter color brown to the center-right.

Ethical considerations

Ethical considerations should be made when doing research. Respondents might refrain from answering questions about personal preferences. Respondents might also refrain from answering questions about specific aspects of their house and/or car. These problems can be resolved by making individual cases anonymous and informing respondents in advance of this fact. This research is justified by the need of knowledge concerning sustainability and what might move the public towards it. Though doing harm by conducting this research seems highly unlikely, it is important to stay respectful. Respondents might feel being less or more sustainable is connected to certain values in this research. It is important that respondents know that this is not the case. Sustainability is not considered to be the equivalent to 'good', just as being not sustainable is not equivalent to 'bad' in terms of ethics (Clifford, et al., 2010).

4. Results

4.1 Reflection on data collection and data quality

A total of six afternoons have been spent collecting these cases. It should be noted that the data quality is low. Energy labels of cars were guessed in more than half of the cases. Cases without a known energy label of their home have been supplemented by means of a tool of the Dutch government (Rijksoverheid, 2017). This tool was reliable. Moreover, some bias might have found its way into the sampling. Especially in the second sample, Oosterparkwijk, portico flats are more frequent. These flats are notoriously hard to sample by going door to door and despite multiple efforts, very few cases from these kinds of buildings found its way into the sample. Therefore, a certain type of demographic does not feature in this dataset. Furthermore, for several analyses, cases without cars were filtered out of the sample. For the Reitdiep sample, this resulted in one case being left out. For the Oosterparkwijk sample however, it resulted in five cases being left out.

4.2 Descriptive statistics

The first sample (Reitdiep) has a total case count of 60 (N =60). The second sample (Oosterparkwijk) has a total case count of 51 (N=51). This means a total of 111 cases have been gathered. The primary variable, the amount of sustainable activities performed per household, shows a normal distribution as can be seen below in figure five. An explanation as to what is a sustainable activity is given in the Methodology chapter (chapter three). This variable measured the total amount of sustainability activities per household. A higher amount indicates a more sustainable household.

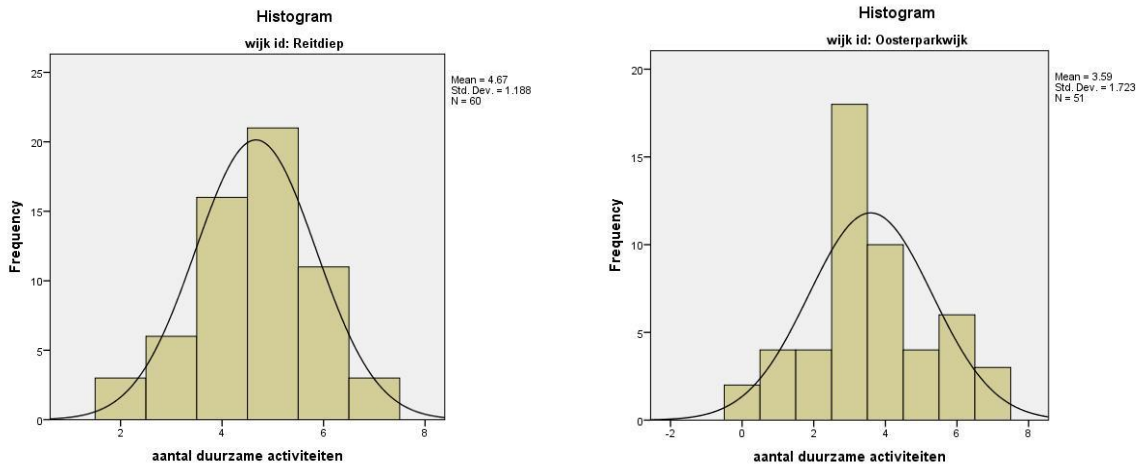

Figure 5: Distributions of the primary variable for Reitdiep and Oosterparkwijk (source: own data)

In addition, the samples show some differences in sustainable characteristics. For instance, for the Reitdiep sample, the median of energy labels of cars is the energy label C. The median energy label in the Oosterparkwijk sample is the label D. This means that cars in the Oosterparkwijk are in general slightly less environmental-friendly.
The same applies to energy labels of houses. Oosterparkwijk scores a median label B while Reitdiep scores a median label A.
Furthermore, a difference is noticed when comparing the most popular type of car. The most popular type of car in Reitdiep is diesel. In the Oosterparkwijk however, the most popular type of car is petrol. Reitdiep seems to be slightly more sustainable than Oosterparkwijk. The table below confirms this.

Descriptive	**Reitdiep (N= 60)**	**Oosterparkwijk (N= 51)**
Total amount of sustainability activities in the household	280	183
Average amount of sustainability activities in the household	4.67	3.59
Most frequent energy label (cars)	C	D
Most frequent energy label (households)	A	B

4.3 Secondary questions

This section will discuss each question (and related hypothesis) independently. All results are presented for each neighborhood independently. This means that two results are given for every hypothesis. A comparison of the results can then be made in the following discussion. The relevant SPSS outputs, ordered chronologically, can be found in appendix 2.

1. To what extent is there a relation between the type of car owned and the number of sustainable activities performed per household?

For this hypothesis, respondents not owning a car were filtered out. After this, a Kruskal-Wallis test was conducted because the data did not meet the requirements for a One-way ANOVA (the dispersion within groups was not normally distributed and there were too little cases per group).
This test was insignificant for the first sample Reitdiep. It was however significant for the second sample Oosterparkwijk.

Kruskal Wallis Test	Significance (at the 95% significance level)	H0 rejected?
Reitdiep (N = 59)	0.132	No
Oosterparkwijk (N = 46)	0.018	Yes

This means that no significant differences have been identified between groups of car types for the Reitdiep sample.
This also means that at least one significant difference between groups was identified in the Oosterparkwijk sample. No further conclusions concerning the strength or direction of this difference can be drawn on the basis of this dataset.

2. To what extent is there a relation between the type of car owned and the total estimated sustainability score?

For this hypothesis, respondents not owning a car were filtered out. A Kruskal-Wallis test was conducted because the data did not meet the requirements for a One-way ANOVA.
This test showed no significant differences in the amount of sustainable activities performed in the household between groups.

Kruskal Wallis Test	Significance (at the 95% significance level)	H0 rejected?
Reitdiep (N = 59)	0.421	No
Oosterparkwijk (N = 46)	0.322	No

This means that there is no relation between the type of car owned and the total estimated sustainability score.

3. To what extent is there a relation between mode of transportation most used and the number of sustainable activities performed per household?

For this test, the variable 'mode of transportation most used' is tested against the number of sustainable activities performed per household. A Kruskal-Wallis test was conducted because the data did not meet the requirements for a One-way ANOVA.
This test showed no significant differences in the amount of sustainable activities performed per household between groups.

Kruskal Wallis Test	Significance (at the 95% significance level)	H0 rejected?
Reitdiep (N = 60)	0.367	No
Oosterparkwijk (N = 51)	0.121	No

This means that the mode of transportation most used does not affect the amount of sustainable activities performed per household significantly in both samples. No spillovers have been identified between sustainable mobility and sustainable households for this hypothesis.

4. To what extent is there a relation between energy labels of cars and energy labels of households?

For this hypothesis, the respondents without cars were left out of the sample. A Wilcoxon Signed Rank Test was conducted. The dataset did not meet the requirements for a chi-squared test (A maximum of 20% of the cases with an expected count below five and no cases with an expected count below 1). The test showed a significant result for both samples.

Wilcoxon Signed Rank Test	Significance (at the 95% significance level)	H0 rejected?
Reitdiep (N = 59)	0.000	Yes
Oosterparkwijk (N = 46)	0.003	Yes

For the Reitdiep sample, the positive count for energy labels of houses was largest. This means that the situation where someone has a higher (more environmentally friendly) energy label for their house than for their car occurs more often than the other way around.

Energy Label Home – Energy Label Car (Reitdiep Sample)	**N**
Negative ranks	4
Positive ranks	42
Ties	13
Total	59

Energy Label Home – Energy Label Car (Oosterparkwijk Sample)	**N**
Negative ranks	6
Positive ranks	29
Ties	11
Total	46

In an effort to identify the direction of the correlation between energy labels of both cars and households in a broader perspective, a Spearman's rho correlation test was conducted over both samples combined. Subsequently, two other Spearman's Rho correlation tests were conducted for both samples separately to identify differences between the two neighborhoods. These tests revealed two interesting correlations.

Spearman's Rho Correlations (both samples combined)	Correlation Coefficient	Significance (at the 99% significance level)
Energy label car – energy label household	0.263	0.007

This means that for the city of Groningen, a positive correlation is found between the energy labels of both cars and households. In other words, if one label is higher (more sustainable), the other is expected to also be higher.

Spearman's Rho Correlations (Reitdiep sample)	Correlation Coefficient	Significance (at the 95% significance level)
Energy label car – energy label household	0.312	0.018

This means that in the Reitdiep neighborhood, a similar correlation is found. The hypothesis - energy label of car leads to higher energy label of house – can therefore be approved for both the city of Groningen as a whole and the Reitdiep neighborhood. No correlations were found for the Oosterparkwijk neighborhood.

5. To what extent is there a relation between age and the amount of sustainable activities performed in the household?

This hypothesis was tested by running a single linear regression analysis. The aim was to find out whether age was an influencing factor for sustainable activities performed in the household. This test did not find age to be a strong predictor of the amount sustainable activities performed in the household.

Single Linear Regression	**F**	**Significance**	**Adjusted R Square**
Model Reidiep (N = 60)	1.193	0.279	0.003
Model Oosterparkwijk (N=50)	2.110	0.153	0.022

This outcome means there is no linear relation between age and the amount of sustainable activities performed in the household. In other words, the variable age is not a strong predictor of the variable amount of sustainable activities performed in the household.

4.4 Discussion

The results of the analysis show little evidence for positive or negative spillover effects of pro-environmental behaviour. Statistical analysis of the data showed almost no significant differences in the data. This has been caused to some extent by the way the data was measured and collected, resulting in too little cases. This has implications for which type of statistical test can be conducted. Nevertheless, some interesting findings are to be discussed.

The first, second, third and fifth hypothesis have not been assumed. No behavioural spillover effects, positive or negative, have been identified there. The fourth hypothesis showed that for the Reitdiep sample, homes often have a higher (more environmentally friendly) energy label than the car. This is a result that confirms the image of this neighborhood. The analysis of descriptive statistics of both samples confirms this. Reitdiep is a relatively new neighborhood in terms of age, it is less dense and residents earn more. Therefore, it was built with modern needs in mind. A higher level of attention was paid to energy consumption and energy saving, resulting in higher energy labels.
However, the non-parametric nature of the correlation test needs to be respected. Thus, the results stated above are less robust than results from a parametric test. In conclusion, there is reason to believe a relation like the one described in the fourth hypothesis exists to some extent for both the city of Groningen and Reitdiep. Further claims about this relation cannot be made based on this study.

The previous comes down to the following. Within the two neighborhoods, very little spillovers of 'green' behaviour have been observed. This can have multiple causes.
Firstly, owners of an environmental-friendly house do not always intend to be sustainable. Respondents simply liked the aesthetics of the house and did not feel anything for sustainability, despite living in a home with the highest energy label. The same goes for electric or hybrid cars. One might own such cars because of favorable financial benefits. Ownership of something sustainable does therefore not equate having a pro-environment mindset. This can be explained by Halkier (1997, in (Thogersen & Ölander, 2003). It is argued there that people to some extent perform easier pro-environmental activities like recycling to avoid having to perform more difficult actions like cycling to work or buying an electric vehicle.

Secondly, respondents felt like an electric or hybrid car does not give them the feeling of freedom a regular fossil fuel car gives them. In other words, technological advancements have not come far enough yet to make regular cars obsolete. Thus, a person might have a very sustainable home but a regular car.

Thirdly, the absence of a behavioural spillover effect is explained by the nature of an individual's decision to engage in a pro-environmental activity (Truelove, et al., 2014). In their theoretical framework, the argument is made that a calculation based decision towards sustainability action does often not lead to net spillover effects. In addition, two other elements provide an explanation for spillovers. The attribution people provide for sustainability behaviour and the characteristics of the behaviour themselves are used to rationalize different behavioural spillovers, positive or negative (Truelove, et al., 2014).

Finally, the results of this research are largely not in line with the conceptual model as formulated in chapter two. While it could be that these theories simply do not apply to this research, it is more likely that the lack of spillovers is explained by the small amount of cases. The consistency and identity effects can be used to explain the one positive spillover effect identified by this research. People have an urge to be consistent in their behaviour and therefore act consistent between sustainability domains.

Also, people who identify as pro-environmental wish to behave in a manner which strengthens this identity, resulting in more pro-environmental behaviour across domains.
In conclusion, one spillover effect has been observed. This result is remarkable. Though not strong, a correlation has been found between energy labels of cars and households. Nykvist and Whitmarsh (2008) state an energy transition is needed. This result, a spillover between the two domains, directly aids that endeavor. In addition, they provide an explanation for the modesty of spillover relations between domains. Spillover effects, especially in behavioural sciences, are subjected heavily to contingency (Nykvist & Whitmarsh, 2008). As stated above, sustainable behaviour in one domain might fit a person better than another domain. Which sustainable activities are performed are largely determined by our backgrounds and surroundings. To end, the notion of a possible positive spillover effect between the mobility and household domains in Groningen provides an interesting starting point for policy-makers and spatial planners.

5. Conclusions

The aim of this research was to identify spillovers in sustainability behaviour between two domains: the mobility and the household in two neighborhoods in the city of Groningen, the Netherlands. This is relevant because the world now faces the challenge of climate change. Because of this, policy-makers are trying to influence the way people think and act in terms of sustainability. In other words, a transition towards sustainability and environment-friendly behaviour is on our hands. This transition will come about through technological advancements like the electric vehicle and green ways of harvesting energy. Integrated planning, policy-making and technological innovations hold the keys to a future without fossil fuels. This transition can be aided further by the concept of spillover effects (both positive and negative) between pro-environmental behaviours. Consistency and identity effects are used to explain behavioural spillovers. This research aimed to fill in the blank surrounding spillovers between two specific domains, the mobility and the household. Statistical analysis of the acquired data did not find any conclusive spillovers between the two domains. Nevertheless, a correlation between energy labels was observed. This correlation is, in line with findings by Nykvist and Whitmarsh (2008), modest. This indicates the contingent nature of such relations. These findings present opportunities for policy-makers and spatial planners. This study finds its strength in the combination of behavioural science and geography. Weaknesses of this study are the small number of cases and capacity constraints.

5.1 Recommendations

This research was limited by capacity constraints commonly associated with a bachelor's thesis. However, this thesis resembles my first real research. With the exclusion of a minor setback in the initial stages of this study, I am pleased with the process overall. Therefore, I recommend this research – or something similar – is conducted on a much larger scale.

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Appendix

Appendix 1: Questionnaire

Bachelor Thesis 2017: Enquête duurzaamheid

RIJKSUNIVERSITEIT GRONINGEN
FACULTEIT DER RUIMTELIJKE WETENSCHAPPEN
Contactgegevens:
Naam: Hessel van Slooten
Studentnummer: s2787482
Email: h.van.slooten@student.rug.nl
Website: http://www.rug.nl/frw/

Leuk dat u mee wilt doen aan dit onderzoek! In dit onderzoek wordt geprobeerd te inventariseren hoeveel duurzame activiteiten men onderneemt in combinatie met welk type vervoer men gebruikt. Deze enquête is volledig **anoniem**. Uw antwoorden worden alleen gebruikt voor dit onderzoek en kunnen niet worden gekoppeld aan een specifiek persoon. Het invullen van de enquête duurt slechts **drie minuten**. Voor vragen achteraf kunt u contact opnemen middels de bovenstaande gegevens.

1. Wat is uw leeftijd?

…….

2. Wat is uw geslacht?
   - Man
   - Vrouw

3. Wat is uw postcode?

……

4. Geef door middel van de cijfers 1 tot en met 4 aan welk vervoerstype u het meest gebruikt per week. *Hierbij is 1 het type vervoer dat u het meest gebruikt en 4 het type vervoer dat u het minst gebruikt.*
   - Fiets ……
   - Auto ……
   - Openbaar vervoer ……
   - Wandelen ……

5. Welk type auto heeft u? Omcirkel wat voor u van toepassing is. *U kunt deze vraag overslaan als u geen auto bezit. Ga anders uit van uw meest duurzame auto.*
    - Elektrisch
    - Hybride
    - Gas
    - Diesel
    - Benzine

6. Stelling: ik lease mijn auto. Geef aan wat voor u van toepassing is.
    - Ja
    - Nee

7. Stelling: ik overweeg serieus (of heb serieus overwogen) om een elektrische auto aan te schaffen. Omcirkel wat voor u van toepassing is.
    - Helemaal niet mee eens
    - Niet mee eens
    - Neutraal
    - Mee eens
    - Helemaal mee eens

8. Stelling: ik weet welk energielabel bij mijn auto hoort. Geef aan wat voor u van toepassing is. *Ga uit van uw meest duurzame auto.*
    - Ja
    - Nee

9. Omcirkel wat voor u van toepassing is. Mijn auto hoort bij het energielabel:
   Als u bij de vraag hiervoor 'nee' heeft geantwoord kunt u hier een inschatting maken. Het energielabel A staat voor zeer zuinig, het energielabel G staat voor niet zuinig.
    - A
    - B
    - C
    - D
    - E
    - F
    - G

10. Zet een kruisje in het vak dat voor u het meest van toepassing is:

	Ja	Nee
Mijn huis heeft zonnepanelen		
Mijn huis maakt gebruik van windenergie		
Mijn huis maakt gebruik van aardwarmte (geothermische energie)		
Mijn huis is voorzien van een zonneboiler		
Mijn huis maakt gebruik van 'groene stroom' (van bijvoorbeeld leveranciers zoals Essent)		
Mijn huis wekt op een andere manier stroom op dan hierboven genoemd, namelijk……..		
Mijn huis is voorzien van een 'slimme' thermostaat		
Mijn huis is voorzien van een klok-thermostaat		
Mijn huis is voorzien van een HRe-ketel		
Mijn huis is voorzien van dubbel glas		
Mijn woning heeft een 'groen dak'		

11. Omcirkel wat voor u van toepassing is. Mijn huis heeft het energielabel:
    Het energielabel A staat voor zeer zuinig, het energielabel G staat voor niet zuinig.
    - A
    - B
    - C
    - D
    - E
    - F
    - G

12. Geef op een schaal van 1 tot 10 per stelling aan in hoeverre de volgende stellingen op u van toepassing zijn.
    Hierbij staat 1 voor helemaal niet van toepassing en 10 voor heel erg van toepassing.

    - Ik maak gebruik van LED-verlichting thuis - ……
    - Mijn woning is geïsoleerd - ……..
    - Ik doe aan carpooling - ……..
    - Ik maak zo vaak mogelijk gebruik van een fiets in plaats van een auto - ……
    - Ik maak zo min mogelijk gebruik van plastic tasjes bij de supermarkt - ……
    - Ik doe aan recycling - ……..
    - Ik koop tweedehands producten uit duurzaamheidsoverwegingen - ……
    - Ik let bij het kopen van producten op het energielabel - ……
    - Ik vind duurzaamheid een belangrijk thema - ……..
    - Ik probeer duurzamer te leven - ……

Einde enquête, bedankt voor het invullen!

Appendix 2: Relevant SPSS-output

Statistics[a]

		energielabel auto	energielabel huis	brandstoftype auto
N	Valid	59	60	59
	Missing	1	0	1
Mean		4.86	6.53	1.95
Median		5.00	7.00	2.00
Mode		4	7	1
Sum		287	392	115

a. wijk id = Reitdiep

Statistics[a]

		energielabel auto	energielabel huis	brandstoftype auto
N	Valid	46	51	46
	Missing	5	0	5
Mean		4.39	5.31	1.41
Median		4.00	6.00	1.00
Mode		4	7	1
Sum		202	271	65

a. wijk id = Oosterparkwijk

Statistics[a]

aantal duurzame activiteiten

N	Valid	60
	Missing	0
Mean		4.67
Median		5.00
Mode		5
Std. Deviation		1.188
Minimum		2
Maximum		7
Sum		280

a. wijk id = Reitdiep

Statistics[a]

aantal duurzame activiteiten

N	Valid	51
	Missing	0
Mean		3.59
Median		3.00
Mode		3
Std. Deviation		1.723
Minimum		0
Maximum		7
Sum		183

a. wijk id = Oosterparkwijk

Test Statistics[a,b,c]

	aantal duurzame activiteiten
Chi-Square	5.293
df	3
Asymp. Sig.	.152

a. wijk id = Reitdiep

b. Kruskal Wallis Test

c. Grouping Variable: brandstoftype auto

Test Statistics[a,b,c]

	aantal duurzame activiteiten
Chi-Square	10.080
df	3
Asymp. Sig.	.018

a. wijk id = Oosterparkwijk

b. Kruskal Wallis Test

c. Grouping Variable: brandstoftype auto

Test Statistics[a,b,c]

	Totscore
Chi-Square	2.817
df	3
Asymp. Sig.	.421

a. wijk id = Reitdiep

b. Kruskal Wallis Test

c. Grouping Variable: brandstoftype auto

Test Statistics[a,b,c]

	Totscore
Chi-Square	3.489
df	3
Asymp. Sig.	.322

a. wijk id = Oosterparkwijk

b. Kruskal Wallis Test

c. Grouping Variable: brandstoftype auto

Test Statistics[a,b,c]

	aantal duurzame activiteiten
Chi-Square	3.166
df	3
Asymp. Sig.	.367

a. wijk id = Reitdiep

b. Kruskal Wallis Test

c. Grouping Variable: meest gebruikt vervoersmiddel

Test Statistics[a,b,c]

	aantal duurzame activiteiten
Chi-Square	5.821
df	3
Asymp. Sig.	.121

a. wijk id = Oosterparkwijk

b. Kruskal Wallis Test

c. Grouping Variable: meest gebruikt vervoersmiddel

Ranks[a]

		N	Mean Rank	Sum of Ranks
energielabel huis - energielabel auto	Negative Ranks	3[b]	13.67	41.00
	Positive Ranks	45[c]	25.22	1135.00
	Ties	11[d]		
	Total	59		

a. wijk id = Reitdiep

b. energielabel huis < energielabel auto

c. energielabel huis > energielabel auto

d. energielabel huis = energielabel auto

Test Statistics[a,b]

	energielabel huis - energielabel auto
Z	-5.663[c]
Asymp. Sig. (2-tailed)	.000

a. wijk id = Reitdiep

b. Wilcoxon Signed Ranks Test

c. Based on negative ranks.

Ranks[a]

		N	Mean Rank	Sum of Ranks
energielabel huis - energielabel auto	Negative Ranks	6[b]	22.50	135.00
	Positive Ranks	29[c]	17.07	495.00
	Ties	11[d]		
	Total	46		

a. wijk id = Oosterparkwijk

b. energielabel huis < energielabel auto

c. energielabel huis > energielabel auto

d. energielabel huis = energielabel auto

Test Statistics[a,b]

	energielabel huis - energielabel auto
Z	-2.974[c]
Asymp. Sig. (2-tailed)	.003

a. wijk id = Oosterparkwijk

b. Wilcoxon Signed Ranks Test

c. Based on negative ranks.

Correlations

			energielabel auto	energielabel huis
Spearman's rho	energielabel auto	Correlation Coefficient	1.000	.263**
		Sig. (2-tailed)	.	.007
		N	105	105
	energielabel huis	Correlation Coefficient	.263**	1.000
		Sig. (2-tailed)	.007	.
		N	105	111

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations[a]

			energielabel auto	energielabel huis
Spearman's rho	energielabel auto	Correlation Coefficient	1.000	.307*
		Sig. (2-tailed)	.	.018
		N	59	59
	energielabel huis	Correlation Coefficient	.307*	1.000
		Sig. (2-tailed)	.018	.
		N	59	60

*. Correlation is significant at the 0.05 level (2-tailed).

a. wijk id = Reitdiep

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.142[b]	.020	.003	1.187

a. wijk id = Reitdiep

b. Predictors: (Constant), leeftijd

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.679	1	1.679	1.193	.279[c]
	Residual	81.654	58	1.408		
	Total	83.333	59			

a. wijk id = Reitdiep

b. Dependent Variable: aantal duurzame activiteiten

c. Predictors: (Constant), leeftijd

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.205[b]	.042	.022	1.719

a. wijk id = Oosterparkwijk

b. Predictors: (Constant), leeftijd

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.233	1	6.233	2.110	.153[c]
	Residual	141.767	48	2.953		
	Total	148.000	49			

a. wijk id = Oosterparkwijk

b. Dependent Variable: aantal duurzame activiteiten

c. Predictors: (Constant), leeftijd

Appendix 3: Table of Figures